

**Patterns Of Fungal Infections in Sputum of HIV Infected Patients with Lower Respiratory Tract Infections in Relation to CD4+ Lymphatic Counts in Central Medical Centre in Lagos, Nigeria**

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**ABSTRACT**

Fungal infections are serious Public Health Issues, particularly in People Living with HIV-AIDS. Human Immunodeficiency Virus (HIV) causes reduction of Clusters of (CD4) cells resulting to the disease syndrome. People Living with HIV (PLWH) are prone to respiratory infections, especially with mycoses and tuberculosis. Fungal infections cause respiratory tract diseases and other derangement, which include spread of necrosis, neurological disorder, depressed immune system leading to increased morbidity and mortality in PLWH. To detect the types of fungi in HIV positive patients with lower respiratory tract infections. To correlate the types of fungi with the CD4 count in the HIV positive patients. In a cross-sectional study where 250 (200 PLWH and 50 HIV negative) participants attending clinic in Nigerian Institute of Medical Research Yaba, Lagos (NIMR). Expectorated sputa were collected in sterile cups and cultured in SDA, incubated at 25-27° C. Identifications were done using Standard Laboratory Techniques. The CD4 count was done using The Standard Laboratory Techniques. Of the 200 PLWH, 163(81.5%) yielded fungi from their sputum, 19 of 50 (38.00%) HIV negative control had fungal infection ( $P=0.0001$ ). The 163 isolated fungi from PLWA showed *C. albicans* (28.15%), *A. niger* (25.15%), *A. fumigatus* (13.50%), other *Candida* spp. (15.34%), *A. flavus* (7.36%), *Penicillium* spp. (8.60%), while *Geotrichum* spp., *Mucor* spp. and *Cladosporium* spp. had (0.61%) each. For HIV negative participants 2 types of fungi were isolated. Participants with  $CD4^+ < 100/ul$  had (31.90%) of the fungi and those with  $CD4$  cells  $> 400/ul$  had (12.27%) of the total fungal growth with  $P=0.0001$ .

This study has shown that the isolated fungi *C albicans*, *Aspergillus spp*, *Pennicillium spp*, *Geotrichum*, *Cladosporum sp*, the presence of *Candida albicans* in females and the relatively low CD4 count are indications for laboratory Mycological investigations for proper patient management.

**KEYWORDS:** Fungi, HIV, infection, isolation and sputum.

## INTRODUCTION

The Human Immunodeficiency Virus (HIV) is one of the retroviruses that affects man, with effect on the humoral Immunity and a consequent weakening of the immune system. This may lead to the condition known as acquired immunodeficiency syndrome (AIDS).

Human Immune Deficiency Virus (HIV) is one of the obnoxious diseases of public health importance. It attacks the human immunity with a lethal consequence. In Southern Saharan Africa, HIV was reported to be 42.5% among community, while in Nigeria (Obi *et al*, 2006) reported 40% incidence. As WHO fight against HIV/AIDS, other regions have reported alarming rate. In Ghana, Liberia, South Africa (Parvez *et al*, 2013). This alarming rate are still on, yet none has been brought under control as the world is fighting against viruses, COVID-19

(UNAIDS, 2021), and the recent detection of the SARS-CoV-2 XEC Sub-variant- a descendant of the Omicron lineage (National Centre for Disease Control, 2024).

Despite reports on the delirious effects of HIV on the immune system. Not much has been achieved on immune enhancement. The virus primarily attacks the immune defense system making the body extremely vulnerable to the opportunistic infections, including Mycoses. Fungi cause mycoses that exist in nature as one-celled yeast or as branching filamentous mold. They cannot produce their own food; thus they exist as either parasite or saprophytes, absorbing nutrients from organic matter when found in human and animals (Richardson *et al*, 2000).

Scientists have worked towards curbing the effect of mycotoxins on man and the immune system. The reduced immune system cause the surrounding microbioate to come in as

opportunistic pathogens. This include protozoa, fungi, viruses and bacteria. Their presence further depresses the immune system. Cells bearing the CD4 antigen are susceptible to HIV infection, the HIV has affinity especially for the T4 lymphocytes. Once the virus gain entry, it destroys the cells (Ochiabuto *et al*, 2014) reducing the immunity and therefore CD4 count.

One of the major organs affected by HIV/AIDS is the respiratory system, affected by fungi such as *Candida albican*, *Cryptococcus neoformans*, *Histoplasma capsulatum* (Lopez-Oviedo *et al*, 2006). Their effect spam from symptomatic candidiasis to invasive *Coccidioides immitis*. The T4 lymphocytes has a central role in many immunological functions. Its role as defense of the immune system reduces drug effects and therefore CD4 count serve as indicator for detecting HIV infection.

Patients with HIV are more prone to respiratory opportunistic infections caused by *Mycobacterium tuberculosis* complex and other fungal species. Though fungi come in as opportunistic pathogens, they suppress the immune system of the host, thereby causing complications. Despite the fact that they cause complications they are often overlooked.

Therefore, this study sets out to;

- i. To ascertain the species of fungi from the sputum of PLWH.
- ii. To determine the prevalence of pulmonary fungal infections among PLWH
- iii. To access the CD4 count in association with fungal pulmonary infection of PLWH

## METHODS

Two hundred and fifty (250) randomized participants who consented to the study were

sampled and they participated in this study. It was a laboratory-based study and samples were investigated after obtaining their consent. Sputum samples were obtained from the participants. Two sets of samples were collected within three days interval to rule out false positive fungal growths (Ochei *et al*, 2005). Structured questionnaires were used to obtain participants bio-data. Ethical approval was also obtained from Nigerian Institute of Medical Research (IRB/14/267). Participants' data were entered into Excel Spread sheet and analyzed using Fishers Extract statistical software.

### CULTURE OF SAMPLES

Sabouraud Dextrose Agar (SDA) without antibiotic and SDA with antibiotic (Chloramphenicol and Penicillin) were used for the cultivation of the sputum samples. The sputum samples were inoculated on the media in duplicates and incubated aerobically

at 25°C and at 37°C. The plates were examined daily for fungal growth for the period of 4 weeks, after which they were discarded (Cheesebrough *et al*, 2000).

### INVESTIGATION OF SAMPLES

Examination of Samples:

Microscopic examination: Direct Microscopy was done (Tissue Biopsy). The sample containing the fungi was mixed with 10% of KOH (Potassium Hydroxide) and left for 10 minutes. The KOH (Potassium Hydroxide) cleared the tissue samples, enabling visualization of the fungi.

### PROCEDURE FOR KOH TEST

1. In a clean and sterile glass slide, a drop of KOH was placed.
2. A small portion of the specimen was transferred over the KOH and was placed on the cover slip on top.
3. The specimen-KOH mixture was incubated at room temperature for 20

minutes for clearing the sample and digesting cellular debris.

- The sputum was incubated.

4. Examined under a compound light microscope; first at low power (100 X magnification), shifted to high power (400 X magnification).
5. The fungal morphology and arrangement of fungal spores were observed.

Lactophenol blue staining was carried out to observe the fungal morphology.

The Lactophenol Blue: Wet mount preparation was used for staining and observing fungi. The preparation has three (3) components;

- a. Phenol kills any life organism.
- b. Lactic acid preserves fungi structures.
- c. Cotton blue stains the chitin in the fungi cell walls.

#### TECHNIQUES FOR LACTOPHENOL BLUE STAINING

1. On a clean slide, was placed drop of 70% ethanol
2. The fungal specimen was added to the alcohol.
3. The fungal sample of the alcohol was teased with an inoculating loop.
4. Two (2) drops of Lactophenol Cotton Blue Solution was added.
5. The stain was covered with a clean sterile coverslip without making air bubbles to the stain.
6. The stain was examined microscopically at 40X, to observe for fungal spores and other fungal structures.

Germ tube test- was carried out to identify *candida*. Plasma was placed in a tube to observe germ tubes.

#### TECHNIQUES FOR GERM TUBE TEST

1. 0.5 ml of human serum was placed into a small tube.
2. Using a Pasteur pipette, a colony of yeast was gently emulsified in the serum.

3. The tube was incubated at 37°C for 2 to 4 hours.
4. A drop of the serum was transferred to a slide for examination.
5. This was examined microscopically under low and high-power objectives.

## TESTING PRODEDURE FOR CD4 COUNT

1. Cartridge was removed from sealed pouch.
2. Blood sample was applied at a time holding cartridge and transfer tool/finger inclined for smooth sample intake.
3. Filling was stopped when sample collector capillary was full (air bubbles was avoided).
4. Cartridge was held up right during filling.
5. The control window was observed until it turned red.
6. Collector was not remove until control window was completely filled with blood.

7. Sample collector was carefully removed from cartridge.
8. Cartridge cap was completely closed.
9. Cartridge was inserted immediately in to the analyzer.
10. Operator ID entered.
11. Sample ID entered.
12. Result was read in less than 20 minutes on the screen (White *et al*, 2015).

## STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) version 21 was used to analyze the results. Descriptive statistics, frequency, percentage were used for result presentation. Chi-square test was used to check the association between variables, while level of significance was set at  $\leq 0.05$ .

## RESULTS

Results: Distribution of Fungi amongst participants

Of a total of 250 individuals who participated in this study, 200 were PLWH and 50 were control. Of the 200 PLWH, 94 were males and 156 females of these 163 (81.5 %) fungi were isolated while the controls recorded 19(38.00%) fungi. The occurrence of fungi ( $P=0.0001$ ) was significant for PLWH. Occurrence of fungi in females living with HIV/ AIDS and controls were (61.3- 68.4%) while males were in the range of (31.6- 38.7%) (Tables 1 and 2)

There was no significant association in the distribution of pulmonary fungal infection and gender of participants ( $P = 0.1429$ ). Of the 163 fungal isolates recorded, *C albicans* was the highest isolated with a total 46(28.22%), the isolated fungi and distributors were as follows; the females recorded *C. albicans*, 28 (60, 8%) *Aspergillus niger* 28 (60.87%), other *Candida spp.* 16(64.0%). While the males rewarded

17(41.46%). 9 (40.91), 9(36.00%) (Table3, fig1)

### DISTRIBUTING OF FUNGI BY GENDER

The Isolated fungi were as follows; the females recorded *C albicans* 28 (60, 8%), *Aspergillus niger* 24 (58.54) other (Candidate spp. 16 (64.0) %) while males recorded 17, (41.46%), 9 (40%), 9 (36.00%) respectively (Tables 3, Fig. 1).

Comparative distribution of fungi amongst HIV+V and HIV-VE, Participants; of the total of (156), HIV + and HIV – female participants. (5- 69.2) who had *Candida spp.* *A. niger*, *A. fumigatus* and *A. flavus*. Isolates were statistically significant with  $P < 0.005$  while *A. niger* was not significant at  $p= 0.785$  (Table 4).

The Total of 94 male participants who had *Candida spp* and *A. niger* were Isolated with  $P=0.005$  indicating no significance, *C.*

*albicans* (P-0.2247), *A. niger* (P- 0.4366),

also showed no significance

Of the 19 PLWH Participant who had fungi isolated, the females had *C albicans* 9 (69.2%), *A. niger* 2 (15.4%), *A. fumigatus* and *A. flavus* were 1(7.7%). The male participant recorded, 3(50.0%), 3 (50.0%) and *A. flavus* (0.00%) respectively (Table 4 and 5).

## DISCUSSION

Invasive fungal disease due to Aspergillosis and other fungal disease have emerged as prominent cause of morbidity and mortality worldwide among the immunocompromised host (Toma *et al*, 2004). The presence of invasive fungi in the sputum of PLWH calls for concern, as this has been associated with high morbidity and mortality (Mohammed *et al*, 2017), indicating the need for investigation of mycoses during management of PLWH.

Amongst the notably isolated organisms was *candida albicans*, known to cause disease in the lungs, Kidney and various organs of the body, especially in PLHA, which is predisposing condition, chest disease is frequently bronchopulmonary or pulmonary candidaosis varies from inflammation to severe infection such as tuberculosis (Centers for Disease Control and Prevention, 2021).

Another group of fungi were Aspergillus spp known to cause aspergillosis and certain spp of Penicillium. These fungi produce mycotoxins (aflatoxin) (Segal, 2009) which can cause severe damage or even cancer in the liver of animals ingesting them. *Cryptococcus* affects the lungs and the central nervous system (Perfect *et al*, 2010). Mucor can cause Mucormycosis, an acute and fatal infection which can also affect the lungs and central nervous system. Geotriclum spp causes geotriculosis, affects various parts of the human body. *Cladosporium* causes abscess in humans (Denning *et al*, 2011). The frequency with which various fungi were isolated from the sputum is a pointer to the need for laboratory investigation of fungi during management of PLWH.

Gender distribution of fungi was skewed towards the females. The females had higher rate of fungal isolated, when compared to

their male counterparts. This could be due to hormonal differences or cell mediated immunity (Adler, 2008). Frequency distribution *Candida albicans* was higher in the females, this is expected as *Candida albicans* are usually a common opportunistic pathogen in the female genital tract causing thrush especially the PLWH. Although this also could be related to hormonal issues.

The *P*- values obtained from fungi isolated from the sampled population simply showed that mycoses was a common in those PLHA and that gender had a role in the distribution of fungi. The females were more prone to fungal infections especially *Candida albicans*. This further espouses the need to investigate and treat mycotic infections promptly to avoid further complications (Masur *et al*, 2014).

The low CD4 count (<100) recorded for those living with HIV/ AIDs which could be linked to the isolation of fungi in the group, this is

expected, since fungi break down the immune system contrary to HIV -VE individuals who recorded 89.5% for CD4 +4 (>400) count compared to PLWHA with 1.8%. These are pointers to the derogative role of fungi in PHLH with a further emphasis on the need for laboratory investigation of fungi for better patient's managements (World Health Organization, 2020).

In the light of the above findings, the prevalence of 81.5% for opportunistic fungi, culminates to the need for policy on, isolation, identification and susceptibility testing of fungal agents and therapy for mycoses during management of PLWH, to avoid further complications.

**CONCLUSION**

1. The isolation of various fungi which included, *C albicans*, *Aspergillus* spp *Pennicillium* spp. *Geotrichum* and *Cladosporum* sp in PLWH, Has shown the need for Laboratory investigation of mycoses during patients management
2. The female gender had more isolation of fungi particularly *C albicans* than the

- males- the need for special care for females during management of PLWH.
3. The presence of low CD 4 count (<100) in Association with mycoses in the PLWH, suggest the need to treat patient for mycoses so as to boost their immune system

**Table 1: PROFILE OF ISOLATES AMONG PARTICIPANTS**

<b>Mycotic infection</b>	<b>Frequency</b>	<b>%</b>
PLWH	163	81.5
HIV-VE	19	38.0
<b>chi-square</b>	18.059	-
<b>P-value</b>	0.0001	-

**Table 2: PROFILE OF FUNGAL ISOLATES AMONG PARTICIPANTS ACCORDING TO GENDER**

	<b>PLWH</b>		<b>HIV –VE</b>	
<b>Status</b>	<b>Frequency (Freq.)</b>	<b>Percentage (%)</b>	<b>Frequency (Freq.)</b>	<b>Percentage (%)</b>
<b>Female</b>	100	61.3	13	68.4
<b>Male</b>	63	38.7	6	31.6
<b>Total</b>	163	100.0	19	100.0
<b>Chi-square</b>	7.869	-	2.146	-
<b>P- value</b>	0.0050*	-	0.1429	-

\*=Statistically significant

**TABLE 3: GENDER COMPARATIVE DISTRIBUTION OF FUNGI AMONG HIV+VE AND HIV-VE PARTICIPANTS**

<b>Fungi Species</b>	<b>Female (N=163)</b>	<b>Male (41)</b>	<b>Total</b>
<i>Candida albicans</i>	28 (60.87)	18 (39.13)	46 (28.22)
<i>Aspergillus niger</i>	24(58.54)	17 (4) 66	41. (25.15%)
<i>Other Candida spp</i>	16 (64.0)	9 (36.00)	25(15.34)
<i>Aspergillus fumigatus</i>	13 (59.0%)	9 (40.91)	22(13.50%)
<i>Penicillium spp</i>	11 (18. 57)	7 (58.33)	18(%)
<i>Cladosporum spp</i>	1 (0.61)	0(0.00%)	1 (0.61%)
<i>Geotricum spp</i>	1 (0.61)	0(0.00%)	1 (0.61%)
<i>Mucor spp</i>	1 (0.61)	0(0.00%)	1 (0.61%)
p- Value (0.1429)			

**Table 4: COMPARISON OF FUNGAL INFECTION IN HIV POSITIVE AND NEGATIVE PARTICIPANTS**

Fungal Isolates	HIV+ Female		HIV -VE Female		chi-square	P-value
	Freq.	%	Freq.	%		
<i>Candida spp</i>	16	16.0	9	69.2	6.865	0.0088*
<i>A. niger</i>	24	24.0	2	15.4	0.073	0.7865
<i>A. fumigatus</i>	13	13.0	1	7.7	5.8822	0.022*
<i>A. flavus</i>	5	5.0	1	7.7	4.9210	0.010*

\*=Statistically significant

**Table 5: THE PARTERN OF FUNGAL INFECTION IN THE MALE PARTICIPANTS**

Fungal Isolates	HIV+ Male		HIV -VE Male		chi-square	P-value
	Freq.	%	Freq.	%		
<i>Candida spp</i>	9	14.3	3	50	1.474	0.2247
<i>A. niger</i>	17	27.0	3	50	0.605	0.4366
<i>A. fumigatus</i>	9	14.3	0	0	NC	-
<i>A. flavus</i>	7	11.1	0	0	NC	-

**TABLE 6: DISTRIBUTION OF FUNGI ISOLATED IN RELATION WITH CD4 CELLS COUNTS**

CD4 cells/ $\mu$ l	PLWH		HIV -VE		Fungal infection	Chi-square	P-value
	Freq.	%	Freq.	%			
<100	60	36.8	0	0.0	60	NC	-
101-200	58	35.6	0	0.0	58	NC	-
201-300	31	19.0	0	0.0	31	NC	-
301-400	11	6.7	2	10.5	13	0.033	0.8550
>400	3	1.8	17	89.5	20	10.317	P=0.0013
<b>Total</b>	163	100.0	19	100.0	132	-	-

\*=Statistically significant      NC= Not Comparable

Significance:  $P > 0.05$

**TABLE 7: THE PREVALENCE OF FUNGAL INFECTION AMONG PARTICIPANTS**

<b>HIV STATUS</b>	<b>NUMBER OF PARTICIPANTS</b>	<b>FREQUENCY OF FUNGAL INFECTION</b>	<b>PREVALENCE.</b>
<b>HIV +VE</b>	200	163	81.5
<b>HIV -VE</b>	50	19	38.0
<b>TOTAL</b>	250	182	72.8

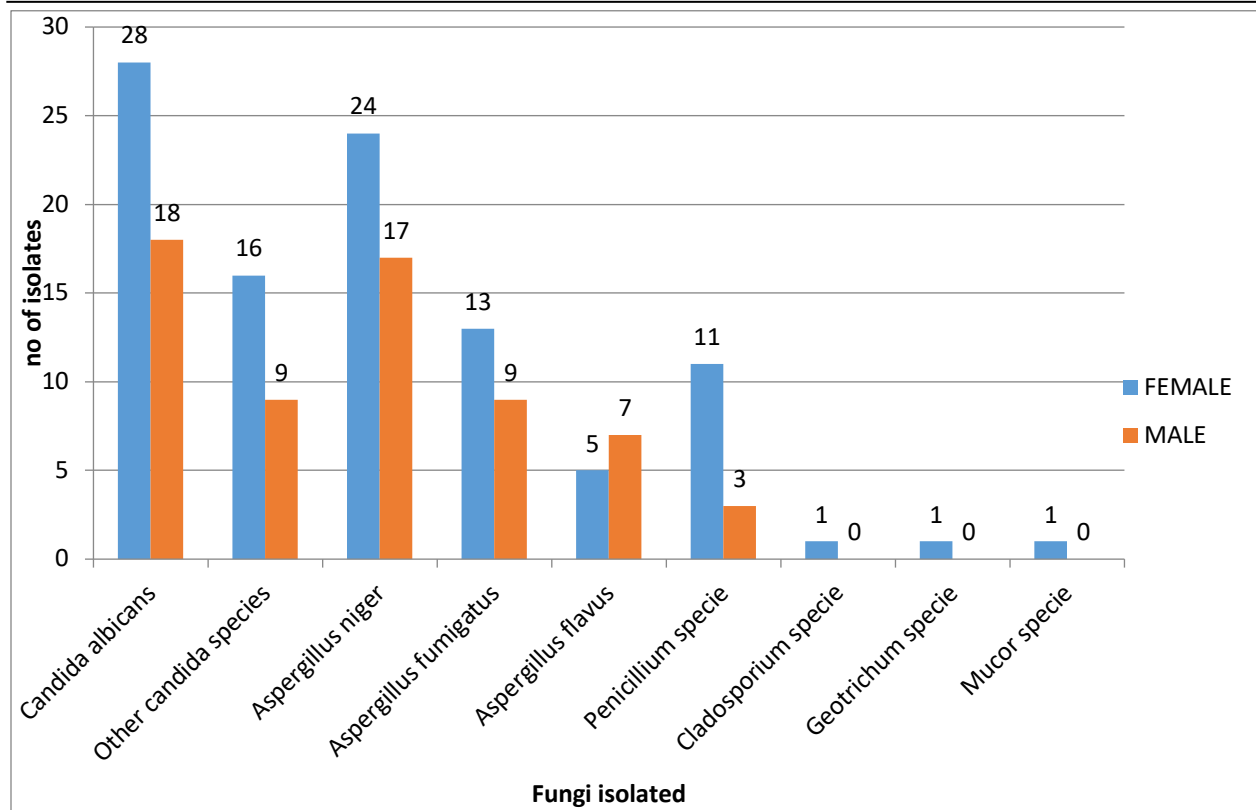


FIGURE I: Frequency distribution of fungal infection among sputum of HIV Positive patients

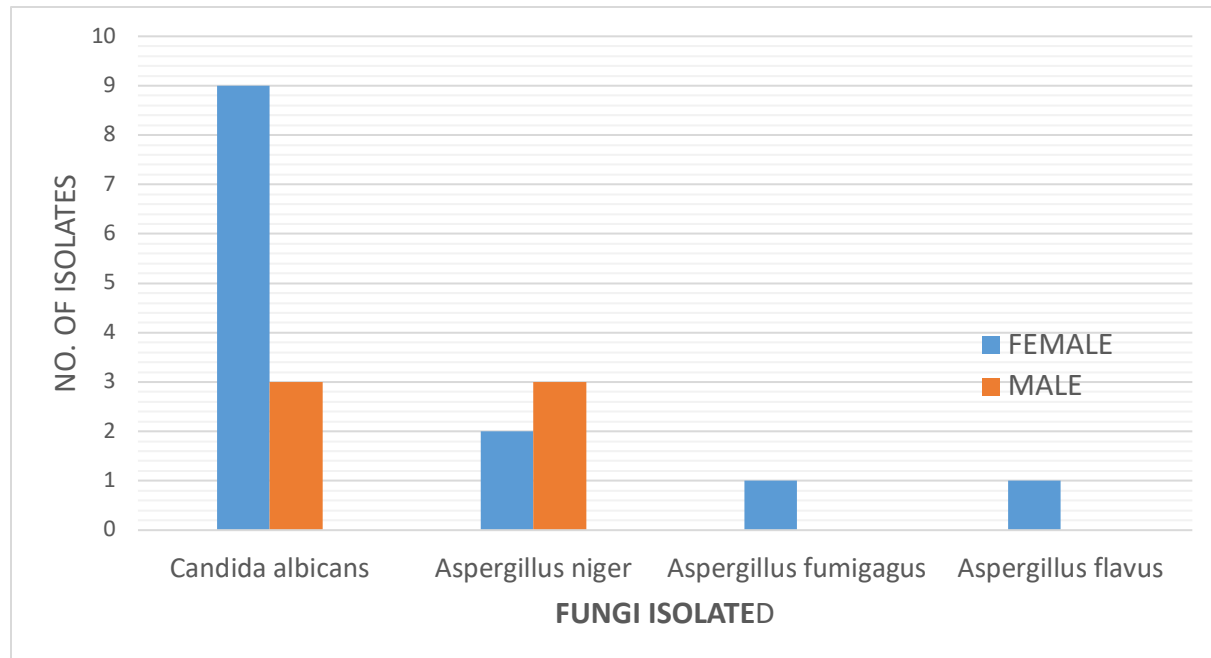


Figure II. Frequency distribution among HIV- Negative Participant

REFERENCES

1. Adler, M.W. (2008) Gender differences in immune responses. *The Lancet*, 371(9606), pp.1775-1776.
2. Centers for Disease Control and Prevention (2021) HIV Opportunistic Infections. [Online] Available at: [cdc.gov](http://cdc.gov)
3. Cheesbrough M. Microbiological test. District Laboratory Practice in tropical countries, etiological agent to Pistiastratiotes extracts. Detection of isolation of *Candida albicans*. Nig. J. of Microbiol. 2000; **19(12)**: 412-419.
4. Denning, D.W., et al. (2011) Burden of fungal infections in the UK. *Journal of Medical Microbiology*, 60(1), pp.1-8.
5. Lopez-Oviedo E, Aller AI, Martin C, Castro C, Ramirez M, Peterman JM, Carton E, Almeida C and Martin-Mazuelos E. Evaluation of disk diffusion method for determining posaconazole susceptibility of filamentous fungi: comparison with CLSI broth micro dilution method. *Antimicrobial agents and chemo.* 2006; **50(3)**:1108-1110.
6. Masur, H., et al. (2014) Management of opportunistic infections in HIV patients. *Annals of Internal Medicine*, 161(4), pp.260-276.
7. Mohammed Talle, Ibrahim M. Hamidu, Idris-Abdullahi Nasir, Abubakar Mursal, Kalama B. Dikwa, Mustapha Jelili, and Peter O. Musa. Prevalence and profile of pulmonary fungal pathogens among HIV-infected patients attending University of Maiduguri Teaching Hospital, Nigeria. *The Egyptian J. of Int. Med.* 2017; **(29)**:11-15.
8. National Centre for Disease Control (NCDC) 2024, *SARS-CoV-2 XEC Sub-variant detection and surveillance update*. NCDC, Abuja. Available at:

- <https://ncdc.gov.ng> (Accessed: 7 December 2024).
9. Obi, C.L., et al. (2006) Epidemiology of HIV in Sub-Saharan Africa. *African Health Sciences*, 6(3), pp.166-172.
10. Ochei J and Kolhatkar. A Laboratory technique in mycology. In Bulakh P. M and Deshmukh, S. Eds. Medical Laboratory Theory and Practice. Tata McGraw-Hill publ. New Delhi. 2005; **(3)**: 1056 -1105.
11. Ochiabuto O.M.T.B, Nwankwo A, Enweani IB, Okoyi JO, Okeke CO, Nwanko M, Nwafulu I and Obi CM Fungal isolation in HIV patients and CD<sup>4+</sup> Count. *Inter STD Res and Rev.* 2014; **2 (2)**:111-122.
12. Parvez Anwar Khan, Abida Malik, Nazish Fatima, M. Shameen. Profile of fungal Lower Respiratory Tract Infection and CD4 count s in HIV positive patients. *Virol Mycol.* 2013; **(2)**:113.
13. Perfect, J.R., et al. (2010) Cryptococcosis. *Lancet*, 375(9717), pp.1789-1801.
14. Richardson M and Ellis M. Symposium on invasive fungal infections. *Hosp Med.* 2000; **61(9)**:321-324.
15. Segal, B.H. (2009) Aspergillosis. *New England Journal of Medicine*, 360(18), pp.1870-1884.
16. Toma F, Gimenez A and Hidalgo A. Imaging of opportunity fungal infection in immune compromised patient. *Eur J of Radiol.* 2004; **51(2)**:130-138.
17. UNAIDS (2021) Global HIV & AIDS Statistics. [Online] Available at: [unaids.org](https://www.unaids.org)
18. White, P.L., et al. (2015) Diagnosis of fungal infections in immunocompromised patients. *European Journal of Clinical Microbiology & Infectious Diseases*, 34(5), pp.919-927.

19. World Health Organization (2020)

Fungal Infections and HIV. [Online]

Available at: [who.int](http://who.int)

## LIMITATION

- Language barrier was a challenge during the collection of the samples, some of the participants could not understand or speak English, and an interpreter was then introduced.
- Duplicates of the samples were required, some participants did not bring the second sample after the three days request their earlier submitted samples became null and void.
- HIV negative patients were screened to avoid any forms of immune depressing conditions like diabetes/cancer could also predispose them to infections that could be similar to HIV/AIDS.

## COMPETING INTERESTS

The authors declare no competing interests

## WHAT IS KNOWN ABOUT THIS TOPIC

- HIV is a major public health challenge with an estimated three million plus living with the virus and Sub-Saharan Africa remains the most severely affected. In Nigeria an estimated prevalence rate of 3.0% in 2014; with almost 1 in 20 adults living with HIV
- HIV related Opportunistic Fungal Infections (OFIs) are important cause of morbidity and mortality in the developing nations like Nigeria. There are many reports available regarding the pattern of OFIs in HIV infected individuals

## WHAT THIS STUDY ADDS

The study has shown that PLWH are prone to fungal infections and that there is need for a policy to be made on investigation of fungi and antifungal susceptibility tests for this group of people for proper management,

treatment and survival. This is so for the following reasons.

- Having the prevalence of 81.5% out of 200 participants among the people living with HIV (PLWH), proves that PLWH are highly susceptible to fungal infections.
- This study showed that sputum of PLWH had significant fungal infections, which calls for proper diagnosis
- The low CD+ 4 count in these individuals can be associated with the various fungi isolated.
- Females had more fungi isolated as compared to male counterparts which calls for more care for this gender during management of PLWH.

developed, organized and coordinated the implementation of the research.

**Gbajabi - Amila Titi** educates the participants on the needs and purpose of the research. Organized and implemented the completion of consents and collection of samples. Being a physician, she also provided clinical interventions to the participants where necessary.

## **AUTHORS' CONTRIBUTIONS**

**Colman Sunday Apagu, Niemogha Mary-Theresa and Toyosi Yekeen Raheem**

**Peters Folake** organized and carryout the Laboratory work.

All authors reviewed and finalized the manuscript. All authors read and approved the manuscript.

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