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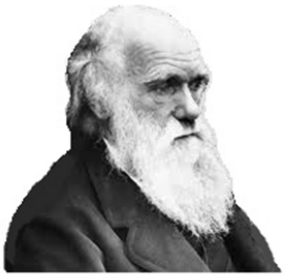

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Prevalence of Tuberculosis among HIV-Positive Patients Attending a Tertiary Hospital in South-Eastern Nigeria

Akubuo Chigaemezu Remmy-Martin[1,*], **Agbasi Ogechi Marvice**[2], **Mejuru Christopher Chidiebere**[1], **Ekwueme Jideofor Chukwuma**[3], **Elendu Melford Uche**[4], **Okereke Levi Kelechi**[2] and **Okorocha Bright Odinaka**[5,6]

[1] Department of Medical Microbiology, Faculty of Biological Science, Imo State University, Owerri, Imo State, Nigeria

[2] Department of Family Medicine, Federal Teaching Hospital Owerri, Imo State, Nigeria

[3] Department of Biology/Microbiology, School Of Industrial And Applied Sciences, Federal Polytechnic Nekede, Owerri, Imo State, Nigeria

[4] Department of Human Physiology, Faculty of Basic Medical Science, College of Medicine, David Umahi Federal University of Health Sciences, Uburu Ebonyi State, Nigeria

[5] Department of Medicine and Surgery, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

[6] Person-Centered HIV Research Team, Department of Clinical Pharmacy and Pharmacy Management, University of Nigeria, Nsukka, Enugu State, Nigeria

*E-mail address: martinakubuo@gmail.com

ABSTRACT

Tuberculosis (TB) remains the most prevalent opportunistic infection and a major cause of mortality among individuals living with HIV (PLHIV), particularly in sub-Saharan Africa. Despite advancements in antiretroviral therapy (ART), Nigeria continues to grapple with significant challenges related to TB/HIV co-infection. This study aimed to evaluate the prevalence of TB in HIV-positive patients at the Federal University Teaching Hospital, Owerri (FUTHO), emphasizing various demographic, clinical, and immunological variables. A cross-sectional study involving 100 HIV-positive adults who attended the FUTHO HIV clinic was carried out. Socio-demographic and clinical data were collected through structured questionnaires. TB diagnosis was conducted using symptom-based screening, Ziehl–Neelsen microscopy, and GeneXpert testing. Data analysis was performed using

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chi-square tests and logistic regression in SPSS version 25. The results indicated that the overall prevalence of TB among PLHIV stood at 30%. The incidence of TB was significantly higher in males (39.5%) compared to females (24.2%, p = 0.042), with the highest rates observed in the 40-49 age bracket (32.1%). We found that prevalence escalated with advancing WHO stages, ranging from 14.3% in Stage I to 50% in Stage IV (p < 0.01). Patients with a CD4 count below 200 cells/μL were at the greatest risk (57.1%) compared to those with counts of 500 cells/μL or greater (9.5%, p < 0.001). Those who had never received ART were disproportionately affected (54.2% vs. 22.4% on ART, p = 0.003). A comprehensive analysis showed that ART-naïve patients with CD4 counts under 200 cells/μL had the highest prevalence (66.7%), while those on ART with CD4 counts of 200 cells/μL or more exhibited the lowest (17.2%). Multivariate regression analysis identified low CD4 count (AOR = 4.72, 95% CI: 1.65-13.51) and ART-naïve status (AOR = 3.41, 95% CI: 1.28-9.06) as key predictors of TB. The prevalence of tuberculosis (TB) among people living with HIV (PLHIV) in this Nigerian tertiary hospital is concerningly high. This scenario is mainly driven by severe immunosuppression and limited access to antiretroviral therapy (ART). The distinct differences across WHO stages, along with the increased risk associated with not starting ART and having low CD4 counts, highlight the urgent requirement for earlier HIV diagnoses, prompt initiation of ART, and more extensive TB prevention strategies. Strengthening diagnostic capabilities and tailoring interventions for high-risk populations are essential to effectively reduce TB-related morbidity and mortality rates in Nigeria.

***Keywords*:** Tuberculosis, HIV, Co-infection, Antiretroviral therapy, CD4 count, WHO stage, Nigeria

1. INTRODUCTION

Tuberculosis (TB) remains the primary cause of mortality from a single infectious agent among people living with HIV (PLHIV), despite the advancements made in enhancing access to antiretroviral therapy (ART) and TB preventive treatment (TPT) (UNAIDS, 2024; WHO, 2024). In 2023, approximately 662,000 PLHIV were identified as having TB, with the highest incidence occurring in the WHO African Region, underscoring the continuing battle between these two diseases (WHO, 2024). The coexistence of TB and HIV in West and Central Africa, particularly in Nigeria, continues to complicate clinical management and hinder the achievement of program objectives aimed at controlling the epidemic.

Tuberculosis (TB) linked to the human immunodeficiency virus (HIV) remains a considerable global public health problem. Worldwide, TB claims more than 5,000 lives daily, while HIV is responsible for over 8,000 deaths each day (WHO, 2023). As noted by WHO (2022), TB impacts about one-third of the global population, whereas HIV affects around 35 million individuals, with 2.1 million new diagnoses. In 2022, a total of 1.3 million people died from TB, including 167 individuals living with HIV/AIDS (WHO, 2023). The World Health Organization reports that 39% of new tuberculosis (TB) diagnoses are believed to be attributed to HIV infection, with roughly 14 million people globally suffering from both infections (WHO, 2023).

Among individuals with HIV, tuberculosis remains the most common opportunistic infection (OI), accounting for approximately 26% of deaths related to AIDS. HIV-positive patients are 20–30 times more likely to develop TB over their lifetime compared to those who are HIV-negative (Nissapatorn et al., 2003).

The burden of co-infection is especially pronounced in Sub-Saharan Africa, notably in Nigeria, where the healthcare system is already under-equipped and overwhelmed, raising

critical concerns surrounding this dual epidemic of TB and HIV (Sabine et al., 2012). Regardless of whether the pathogen is sensitive and effective against anti-TB medications, the risk of mortality from TB is significantly higher among the HIV-infected population (Lumu et al., 2023). In patients with both infections, the connection between HIV and TB is reciprocal and synergistic, with HIV increasing the likelihood of developing active TB and the existence of active TB infection exacerbating the progression of HIV-related immune deficiency (Pawlowski et al., 2021; Tesfaye et al., 2018).

Nigeria remains one of the countries with the highest burden of TB worldwide, and national guidelines consistently highlight the necessity for integrated TB/HIV services to minimize delays in diagnosis, reduce early mortality, and hinder further transmission (Federal Ministry of Health [FMoH], 2023; Kwaghe et al., 2020). The most recent National TB/Leprosy/Buruli Ulcer guidelines, along with TB/HIV clinical guidance, detail collaborative initiatives such as regular bidirectional screening, prompt molecular testing, immediate initiation of ART, and TPT for healthcare facilities, including tertiary referral institutions (FMoH, 2023; FMoH, 2022).

Recent research from Nigerian universities indicates that co-infection rates of TB and HIV remain considerable, although these rates can vary depending on location, patient demographics, and research methodologies. For example, a three-year hospital study in South-Eastern Nigeria reported a concerning prevalence of TB/HIV co-infection and noted disparities in treatment outcomes among affected individuals (Chukwuocha et al., 2023).

In Enugu State, a five-year longitudinal study at a tertiary care facility found a significant prevalence of TB/HIV co-infection and emphasized important factors influencing case detection and patient linkage to care (Nwoga et al., 2024). Research focusing on specific populations also reveals elevated rates of co-infection, stressing the urgent requirement for integrated services tailored to the specific epidemiological landscape (Ochonye et al., 2024). Previous national assessments and meta-analyses affirm that co-infection rates in Nigeria are both elevated and diverse, highlighting the need for continuous facility-level monitoring to enhance local strategies (Reward et al., 2020).

Examining other countries, studies indicate that TB is frequently under-identified in people living with HIV (PLHIV) during standard care, potentially leading to increased early mortality rates and missed opportunities for prevention. These findings align with global assessments that link deficiencies in screening, access to diagnostics, and care integration with the persistent incidence of TB and fatalities among PLHIV (WHO, 2024; UNAIDS, 2024).

In this scenario, Federal University Teaching Hospitals play a vital role as referral and training hubs for implementing and evaluating TB/HIV collaborative initiatives. However, there remains a lack of comprehensive and up-to-date assessments of TB prevalence among individuals living with HIV (PLHIV) frequenting these facilities, with significant variations based on the specific context, particularly in South-Eastern Nigeria.

This study seeks to determine the prevalence of TB among PLHIV receiving treatment at the Federal University Teaching Hospital and to investigate relevant factors that could improve case detection, enhance prevention strategies, and elevate treatment results in tertiary care settings (FMoH, 2023; WHO, 2024).

2. MATERIALS AND METHODS

2. 1. Study Design and Setting

This investigation was a descriptive, cross-sectional study carried out at the HIV Clinic of the Federal University Teaching Hospital, Owerri (FUTHO) in Imo State, Nigeria. FUTHO acts as a vital tertiary referral center in Southeastern Nigeria, primarily serving patients from low-income communities. The HIV clinic functions under the National HIV/AIDS Control Program, delivering crucial services such as counseling, testing, and treatment.

2. 2. Study Population

The subjects of this research were adult patients who tested positive for HIV and visited the HIV clinic during the specified timeframe. Both individuals with prior experience with antiretroviral therapy (ART) and those who were ART-naïve were included in the study.

2. 3. Inclusion Criteria

1) A confirmed positive HIV status verified through the National HIV Testing Algorithm (Determine®, Uni-Gold®, and Stat-Pak®).
2) An age of 18 years or older.
3) The willingness and capability to provide informed consent.

2. 4. Exclusion Criteria

1) Patients currently undergoing treatment for tuberculosis.
2) Patients with incomplete medical records.
3) Patients who were too ill to participate in interviews or provide sputum samples.

2. 5. Sample Size and Sampling Technique

To ascertain the minimum sample size, Cochran's formula for prevalence studies was utilized,

$$n = \frac{Z^2(1-P)P}{D^2}$$

where:

n = the minimum sample size
Z = the standard normal deviation, usually set at 1.960 which corresponds to the 95% confidence interval
P = expected prevalence of TB among HIV patients (33.9%) (Chukwuocha et al., 2024)
D = margin of error (0.05).

This calculation yielded a sample size of 344, which, after factoring in a 10% non-response rate, raised the total to 383 participants.

However for the sake of convenience and as a result of challenges related to time and logistics a total of 100 participants were recruited for our research. A consecutive sampling technique was employed, inviting each eligible patient who visited the HIV clinic during the study timeframe to participate until the targeted population of 100 was reached (Nwoga et al., 2024; Ochonye et al., 2024).

2. 6. Data Collection

2. 6. 1. Socio-demographic and Clinical Data

Data was collected through a structured questionnaire that an interviewer administered, which was modified from the TB screening tool developed by the World Health Organization (WHO, 2021). This instrument enabled us to gather key socio-demographic information (including age, gender, marital status, education level, and occupation), clinical details (such as the duration of HIV diagnosis, ART status, and the presence of any opportunistic infections), as well as potential risk factors (such as smoking habits and alcohol consumption).

2. 6. 2. Tuberculosis Screening and Diagnosis

All participants underwent screening utilizing the WHO's checklist of four symptoms, which includes a cough persisting for two weeks or more, fever, night sweats, and weight loss. Those displaying at least one symptom were requested to submit two sputum samples: one collected immediately and another in the early morning hours. The sputum samples were subsequently analyzed using Ziehl–Neelsen (ZN) staining to detect acid-fast bacilli (AFB). For confirmation, we employed GeneXpert MTB/RIF testing. A patient was classified as TB-positive if either the smear microscopy result or the GeneXpert test returned positive.

2. 7. Data Analysis

The data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics summarized the participants' socio-demographic and clinical attributes. The prevalence of TB was reported as percentages along with 95% confidence intervals. In the bivariate analysis, the associations between TB and various independent factors, such as age, sex, ART status, CD4 levels, and WHO clinical stage were examined, employing either the chi-square test or Fisher's exact test as appropriate. For the subgroup analysis, further stratified evaluations to investigate TB prevalence among different age groups, WHO stages, and ART/CD4 classifications were conducted. In the multivariate analysis, binary logistic regression to identify independent predictors of TB, presenting adjusted odds ratios (AOR) alongside 95% confidence intervals was executed. A p-value below 0.05 was regarded as statistically significant.

2. 8. Ethical Considerations

Ethical approval from the Health Research Ethics Committee of the Federal University Teaching Hospital in Owerri was obtained. Prior to enrollment, all participants gave written informed consent. Confidentiality was maintained by coding questionnaires and lab results, eliminating any personal identifiers. Patients diagnosed with TB were directed to the hospital's Directly Observed Treatment Short-course (DOTS) clinic for complimentary treatment, in accordance with the guidelines established by the National Tuberculosis and Leprosy Control Programme (NTBLCP).

3. RESULT

3. 1. Socio-demographic Characteristics of Participants

A total of 100 HIV positive patients were enrolled for the study with the mean age of 37.4 ± 9.2 years (range: 19-58 years) A considerable segment of the group consisted of women,

representing 62% of the participants, and a majority of them were married, comprising 54% (Table 1). In terms of education, there was a diverse range: 41% had attained secondary education, 35% held tertiary qualifications, and 24% had completed only primary school.

Table 1. Socio-demographic characteristics of study participants (n = 100).

Variable	Frequency (%)
Age group (years)	
18–29	22 (22.0)
30–39	36 (36.0)
40–49	28 (28.0)
≥50	14 (14.0)
Sex	
Male	38 (38.0)
Female	62 (62.0)
Marital status	
Single	28 (28.0)
Married	54 (54.0)
Widowed/divorced	18 (18.0)
Education	
Primary	24 (24.0)
Secondary	41 (41.0)
Tertiary	35 (35.0)

3. 2. Clinical Characteristics

The mean duration of HIV diagnosis was 4.8 ± 2.7 years. A significant proportion 76%, were undergoing antiretroviral therapy (ART), whereas 24% had never been treated with ART. The mean CD4 count was 374 ± 122 cells/μL. According to the World Health Organization (WHO) clinical staging, 21% were categorized as stage I, 39% as stage II, 28% as stage III, and 12% as stage IV (Table 2).

Table 2. Clinical characteristics of participants (n = 100).

Variable	Frequency (%)
Duration since HIV diagnosis	
<2 years	22 (22.0)
2–5 years	47 (47.0)
>5 years	31 (31.0)
ART status	
On ART	76 (76.0)
ART-naïve	24 (24.0)
CD4 count (cells/µL)	
<200	21 (21.0)
200–349	30 (30.0)
350–499	28 (28.0)
≥500	21 (21.0)
WHO clinical stage	
I	21 (21.0)
II	39 (39.0)
III	28 (28.0)
IV	12 (12.0)

3. 3. Prevalence of Tuberculosis

Among 100 participants, 30 (30%) tested positive for Mycobacterium tuberculosis through the Ziehl–Neelsen staining technique (Fig. 1).

3. 4. TB Prevalence Stratified by Age Group

The occurrence of TB remained relatively consistent among various age demographics, with the highest incidence observed in individuals aged 40 to 49 years (32.1%). This suggests that age is not a significant independent variable, unlike CD4 count and ART status. Nonetheless, middle-aged individuals may still face a slightly greater risk, potentially due to prolonged exposure and cumulative immune suppression (Table 3).

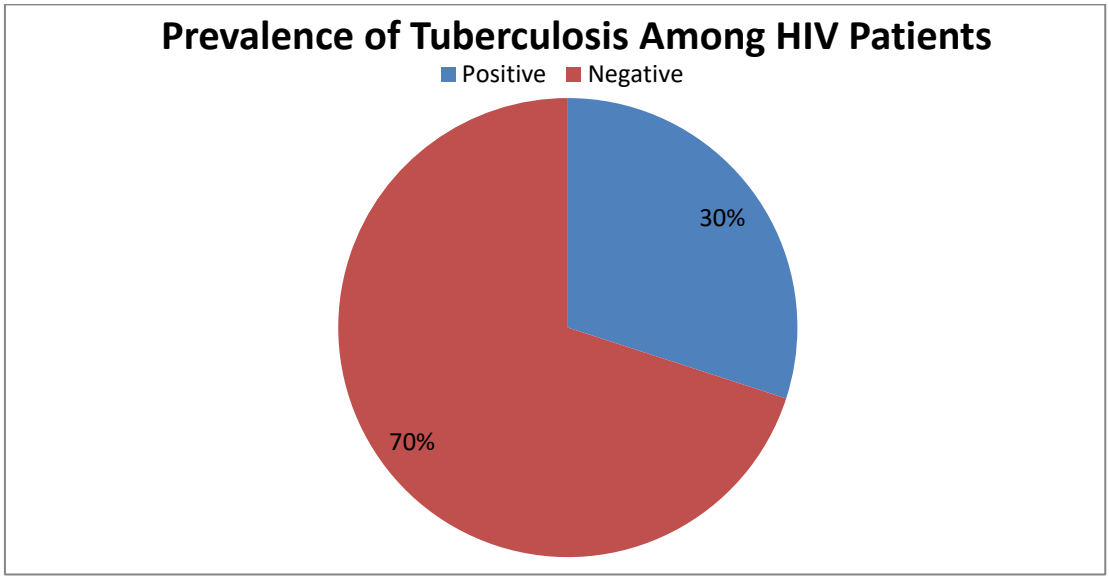

Fig. 1. Prevalence of Tuberculosis among HIV patients.

Table 3. TB Prevalence Stratified by Age Group.

Age group (years)	TB-positive (%)	TB-negative (%)	Total (n = 100)
18–29 (n = 22)	6 (27.3)	16 (72.7)	22
30–39 (n = 36)	11 (30.6)	25 (69.4)	36
40–49 (n = 28)	9 (32.1)	19 (67.9)	28
≥50 (n = 14)	4 (28.6)	10 (71.4)	14
Total	**30 (30.0)**	**70 (70.0)**	**100**

Table 4. Distribution of TB Prevalence by WHO Clinical Stage.

WHO Stage	TB-positive (%)	TB-negative (%)	Total
Stage I (n = 21)	3 (14.3)	18 (85.7)	21
Stage II (n = 39)	9 (23.1)	30 (76.9)	39
Stage III (n = 28)	12 (42.9)	16 (57.1)	28
Stage IV (n = 12)	6 (50.0)	6 (50.0)	12
Total	**30 (30.0)**	**70 (70.0)**	**100**

3. 5. Distribution of TB Prevalence by WHO Clinical Stage

TB prevalence increased progressively with higher WHO clinical stages, beginning at 14.3% in Stage I and escalating to 50% in Stage IV. This underscores a clear association between the advancement of HIV and the likelihood of developing TB, highlighting the necessity for early intervention prior to patients reaching more advanced clinical stages (Table 4).

3. 6. Cross-tabulation of ART Status with CD4 Counts and TB Positivity

This cross-tabulation illustrates the combined influence of ART status and immune function on the risk of TB. Patients who were ART-naïve with CD4 counts below 200 cells/μL exhibited the highest prevalence at 66.7%, whereas those receiving ART with CD4 counts of 200 cells/μL or higher reported the lowest prevalence at 17.2%. These findings affirm that ART significantly reduces the TB burden, with its effects being most pronounced when immune function is preserved (Table 5).

Table 5. Cross-tabulation of ART Status with CD4 Counts and TB Positivity.

ART Status	CD4 Count	TB-positive (%)	TB-negative (%)	Total
On ART (n = 76)	<200 (n =12)	6 (50.0)	6 (50.0)	12
	≥200 (n = 64)	11 (17.2)	53 (82.8)	64
ART-naïve (n = 24)	<200 (n = 9)	6 (66.7)	3 (33.3)	9
	≥200 (n = 15)	7 (46.7)	8 (53.3)	15
Total		**30 (30.0)**	**70 (70.0)**	**100**

3. 7. TB prevalence across various CD4 count categories and ART status.

Patients with low CD4 counts (<200 cells/μL) who had not yet started ART comprised the greatest proportion of TB-positive cases. Conversely, patients with CD4 counts of 200 cells/μL or greater who were on ART had the lowest rate of TB positivity (Fig. 2).

3. 8. Association between TB and Patient Characteristics

The occurrence of tuberculosis (TB) was significantly higher in males, at 39.5%, compared to 24.2% in females ($p = 0.042$). Among individuals with CD4 counts below 200 cells/μL, the prevalence was highest at 57.1%, while those with counts ranging from 200–349 had a prevalence of 30.0%, 350–499 had 17.9%, and those with counts of 500 or more had 9.5% ($p < 0.001$). Furthermore, patients who had never received ART exhibited a higher likelihood of testing positive for TB at 54.2%, in contrast to just 22.4% of those who were on ART ($p = 0.003$) (Table 6).

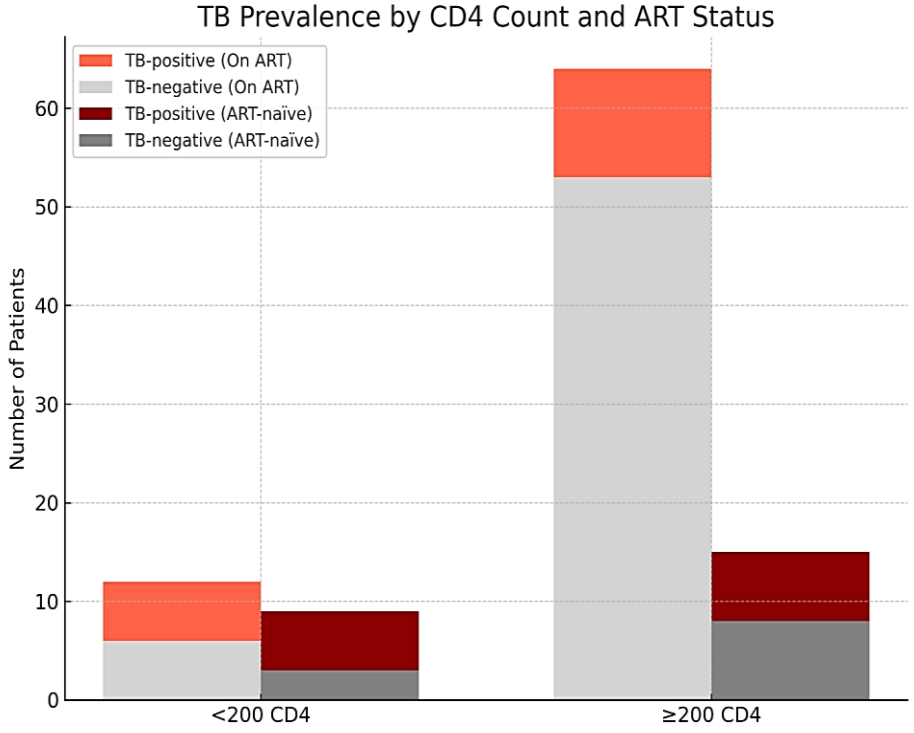

Fig. 2. TB prevalence across various CD4 count categories and ART status.

Table 6. Association between TB positivity and selected patient variables.

Variable	TB-positive (%)	TB-negative (%)	χ^2 (df)	p-value
Sex				
Male (n = 38)	15 (39.5)	23 (60.5)	4.14	0.042*
Female (n = 62)	15 (24.2)	47 (75.8)		
ART status				
On ART (n = 76)	17 (22.4)	59 (77.6)	9.07	0.003*
ART-naïve (n = 24)	13 (54.2)	11 (45.8)		
CD4 count (cells/µL)				
<200 (n = 21)	12 (57.1)	9 (42.9)	16.88	<0.001*
200–349 (n = 30)	9 (30.0)	21 (70.0)		
350–499 (n = 28)	5 (17.9)	23 (82.1)		
≥500 (n = 21)	2 (9.5)	19 (90.5)		

*Significant at $p < 0.05$

3. 9. Multivariate Logistic Regression

In the multivariate analysis (Table 4), a low CD4 count (under 200 cells/μL) (AOR = 4.72, 95% CI: 1.65–13.51, p = 0.004) and being ART-naïve (AOR = 3.41, 95% CI: 1.28–9.06, p = 0.014) were found to be independent predictors of TB infection, even when adjusted for variables such as age, sex, and WHO clinical stage (Table 7).

Table 7. Multivariate logistic regression of predictors of TB infection.

Variable	Adjusted OR	95% CI	p-value
Male sex	1.83	0.78–4.30	0.164
ART-naïve	3.41	1.28–9.06	0.014*
CD4 < 200 cells/μL	4.72	1.65–13.51	0.004*
WHO stage III/IV	2.12	0.91–4.91	0.081

*Significant at p < 0.05

3. 10. Forest Plot of Independent Predictors of TB Infection

The forest plot illustrates adjusted odds ratios (AOR) along with 95% confidence intervals for different factors that affect TB in patients with HIV. The vertical dashed line at AOR = 1 signals no association.

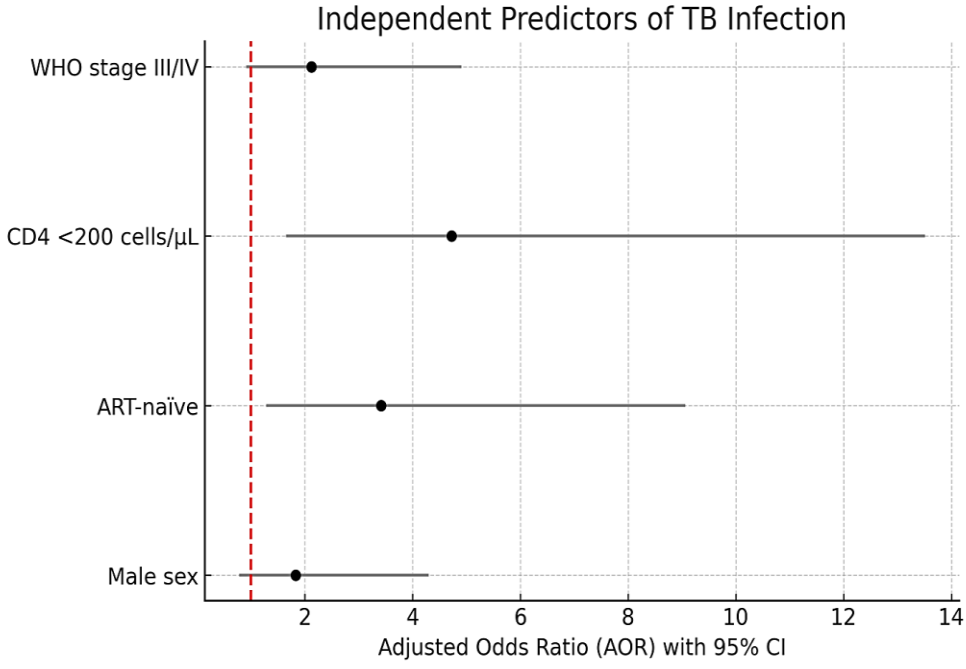

Fig. 3. Forest Plot of Independent Predictors of TB Infection.

Factors positioned to the right of this line indicate a higher risk. Severe immunosuppression (CD4 < 200 cells/μL; AOR = 4.72, 95% CI: 1.65–13.51) is particularly noted as the most significant risk factor, and being ART-naïve (AOR = 3.41, 95% CI: 1.28–9.06) also reflects a significantly increased risk. Male sex (AOR = 1.83, 95% CI: 0.78–4.30) and advanced WHO stage (AOR = 2.12, 95% CI: 0.91–4.91) indicate elevated odds as well, but do not achieve statistical significance, as their confidence intervals intersect with the line representing no effect (Figure 3).

4. DISCUSSION

This research identified a tuberculosis prevalence rate of 30% among patients who are HIV-positive at the Federal University Teaching Hospital in Owerri. This figure is quite concerning, indicating that TB remains a major comorbidity for people living with HIV (PLHIV) in economically challenged regions. Several factors may account for this scenario. For one, Nigeria is among the 30 countries with the highest rates of both TB and HIV, significantly impacting global numbers (WHO, 2024). The coexistence of elevated HIV prevalence alongside a continuing TB epidemic in Nigeria increases the likelihood of dual infections, particularly in tertiary care centers where patients frequently present with advanced disease.

The prevalence found in the study is consistent with earlier research conducted in southeastern Nigeria. For example, Chukwuocha et al. (2023) documented a 33.9% rate of TB/HIV co-infection at the same hospital, while Iwuoha (2021) recorded a 30.8% prevalence at Abia State University Teaching Hospital. The continuation of these high prevalence rates across different institutions over time indicates that current control measures remain inadequate in this area.

Conversely, Nwoga et al. (2024) discovered a lower prevalence rate of 25% in Enugu, which could be attributed to differences in diagnostic techniques and patient demographics. Our results are considerably higher than those reported in multi-country cohorts backed by PEPFAR, where the bacteriologically confirmed TB prevalence among PLHIV was as low as 3%. This discrepancy is likely due to differences in healthcare infrastructure: PEPFAR facilities tend to be better equipped, utilize regular GeneXpert testing, and have strong TB/HIV integration, whereas resource-limited hospitals like ours primarily rely on Ziehl–Neelsen microscopy and frequently encounter patients at later stages of their illness.

Numerous clinical factors illuminate the significant prevalence identified in this research. It was observed that patients with CD4 counts under 200 cells/μL were disproportionately impacted by TB, with over half of these individuals yielding positive smear results. This relationship is biologically understandable, as advancing immunosuppression undermines the body's capability to control latent Mycobacterium tuberculosis infections, resulting in reactivation (Melkamu et al., 2020). Comparable patterns have been documented across Africa, where low CD4 counts continuously correlate with active TB in HIV-positive individuals (Nwoga et al., 2024). The diminished cellular immunity present in advanced HIV contributes to unusual and widespread TB manifestations, and these patients frequently demonstrate higher bacillary loads, leading to increased smear positivity (Meintjes & Maartens, 2024).

Patients who had never been treated with antiretroviral therapy (ART) faced a significantly higher likelihood of having TB compared to those currently on ART.

This observation aligns with global findings suggesting that ART can reduce the risk of TB by as much as 67–84% through partial immune restoration (WHO, 2024). In our analysis, over half of the participants who had never received ART tested positive for TB, while only 22.4% of those undergoing treatment did. The protective effects of ART have been thoroughly outlined, including a meta-analysis by Gupta et al. (2012), which indicated that initiating ART decreases TB incidence regardless of the baseline CD4 count. The considerable TB burden among ART-naïve individuals in our study likely indicates late presentation for care, a persistent challenge in Nigeria, where stigma, poverty, and inadequate health-seeking behaviors often hinder timely diagnosis (UNAIDS, 2021).

Recent observations have highlighted gender disparities, indicating that men are more prone to TB than women. This pattern correlates with other research conducted in Nigeria, where men consistently exhibit a greater burden of TB (Ochonye et al., 2024). Various factors may account for this difference, such as men's higher engagement in occupations that expose them more to TB, a tendency to delay seeking medical care, and elevated levels of smoking and alcohol consumption that can compromise the immune system, increasing their vulnerability to TB (Lönnroth et al., 2010). In contrast, women tend to pursue medical attention earlier due to access to antenatal and reproductive health services, enhancing their likelihood of early detection of both HIV and TB.

While the rate of TB remained relatively constant across various age groups, the highest prevalence was observed among individuals aged 40 to 49 years, reaching 32.1%. This finding is consistent with results from Ethiopia and Uganda, where middle-aged individuals living with HIV (PLHIV) experienced the greatest burden of TB. Factors contributing to this include prolonged HIV infection, occupational hazards, and delays in accessing medical care (Kassa et al., 2019; Kirenga et al., 2015). A comparable trend has been recorded in Nigeria, indicating that the pressures of socioeconomic responsibilities and a gradual decrease in immune function might sustain the elevated risk (Nwoga et al., 2024). These results indicate that while age alone is not a direct predictor, it interacts with other risk factors, such as the late start of antiretroviral therapy (ART) and advanced progression of HIV.

Regarding the relationship between WHO clinical stage and TB risk, a distinct pattern emerges: TB prevalence rises from 14.3% in stage I to an astonishing 50% in stage IV, underscoring the significant correlation between clinical staging and TB risk. This is supported by a study involving a Kenyan cohort, which revealed that individuals in advanced WHO stages had a two-fold higher incidence of TB compared to those in earlier stages. Similarly, a major study conducted in Tanzania showed that PLHIV in stages III and IV were considerably more predisposed to developing TB, highlighting the impacts of severe immunosuppression and other health complications (Range et al., 2012). These results emphasize that late diagnoses and presenting at advanced stages represent significant barriers to controlling TB/HIV in Nigeria, reinforcing the critical need for earlier HIV testing and timely initiation of ART.

The cross-tabulation illustrates how antiretroviral therapy (ART) and CD4 counts interact to affect the likelihood of tuberculosis (TB). Among patients who had never undergone ART and had a CD4 count lower than 200 cells/μL, the prevalence of TB was notably high at 66.7%. Conversely, those receiving ART with CD4 counts of 200 cells/μL or higher exhibited a significantly reduced prevalence of only 17.2%. This observation is consistent with a meta-analysis from South Africa, which revealed that ART can decrease the incidence of TB by up to 65%, with the most substantial protective effects observed in individuals who sustain higher CD4 counts (Gupta et al., 2012).

Comparable results have been reported in studies conducted in Malawi and Botswana, where patients who were ART-naïve faced considerably higher rates of TB, particularly among those with severe immune deficiency (Rangaka et al., 2015). Our results emphasize the vital importance of initiating ART early and enhancing immune function to lower the risk of TB.

The regression analysis confirmed that a low CD4 count (below 200 cells/μL) and being ART-naïve are significant independent predictors of TB. This is in line with global research indicating that immunosuppression and the absence of ART are the most reliable predictors of TB among people living with HIV (PLHIV) (Suthar et al., 2012; WHO, 2024). Although male gender and higher WHO stage were associated with increased odds, these variables did not achieve statistical significance after adjustments, indicating that their impacts are related to ART utilization and immune status. Nevertheless, the disparities in the TB/HIV intersection between genders are well-established in sub-Saharan Africa, where men frequently encounter heightened exposure and less access to healthcare services (Lönnroth et al., 2010; Horton et al., 2016).

Our recorded TB prevalence is 30%, which is significantly higher than the 25% recently documented in Enugu, Nigeria (Nwoga et al., 2024). This figure also greatly exceeds the 3–5% prevalence reported in extensive multicountry PEPFAR-supported cohorts that employ systematic GeneXpert testing and standard TB preventive therapy (Hermans et al., 2012). This disparity underscores how limited resources, insufficient diagnostics, and delays in ART initiation in Nigeria lead to a heavier TB burden compared to the better-supported HIV programs in Southern Africa or through international collaborations. Importantly, the concerning 66.7% prevalence among ART-naïve patients with CD4 counts under 200 cells/μL highlights the critical vulnerability observed in Ethiopia and Uganda, where untreated individuals with significant immunosuppression are central to TB/HIV mortality (Melkamu et al., 2020; Kirenga et al., 2015).The overall high incidence of TB observed in our research further underscores the systemic challenges prevalent in low-income regions. While smear microscopy is a cost-effective option, it carries limitations. With a sensitivity range of only 50–60% when compared to GeneXpert, the prevalence we reported may actually reflect an underestimation of the true situation (WHO, 2021). Moreover, issues such as delayed visits to tertiary hospitals, poor uptake of TB preventive treatments (like isoniazid prophylaxis), and inadequate infection control in congested HIV clinics significantly contribute to sustaining a high TB prevalence (FMoH, 2023). From a public health perspective, these insights underscore the urgent need for integrated TB/HIV services within low-income healthcare facilities. Prompt initiation of ART, consistent TB screenings at every clinic appointment, and the expansion of preventive therapies are essential for effective management. Nevertheless, these initiatives must be coupled with enhancements in diagnostic facilities. The implementation of molecular testing like GeneXpert in Nigerian tertiary hospitals has been variable, and institutions such as FUTHO continue to face resource limitations. Improving access to rapid diagnostic testing, alongside increased health education and stigma reduction campaigns, is vital for decreasing TB-related morbidity and mortality among individuals living with HIV.

5. CONCLUSIONS

This study uncovered a remarkable tuberculosis prevalence rate of 30% among HIV-positive individuals at the Federal University Teaching Hospital in Owerri, emphasizing the

persistent challenge of TB/HIV co-infection in Nigeria. A closer examination revealed that the TB burden was considerably higher among patients with advanced HIV disease (WHO stages III/IV), those with CD4 counts below 200 cells/μL, and individuals who had never undergone antiretroviral therapy (ART). Notably, patients on ART with strong immune function (CD4 ≥200 cells/μL) exhibited the greatest level of protection, while ART-naïve individuals experiencing severe immunosuppression faced distressing risks, with TB prevalence approaching two-thirds. These findings further support the notion that the TB and HIV epidemics are closely linked, with immune decline and the absence of ART as the most significant factors impacting health outcomes.

Age was not a solitary predictor, middle-aged adults exhibited a marginally higher burden, likely due to delays in diagnosis and prolonged exposure. Some differences between genders was also observed, but these did not maintain statistical significance after adjustments, suggesting that treatment and immune status might be affecting these outcomes. In light of these findings, it is crucial to emphasize the importance of integrated TB/HIV services, concentrating on routine bidirectional screening, universal early ART initiation, and the expansion of preventive measures such as isoniazid preventive therapy. Enhancing diagnostic capabilities through broader usage of GeneXpert and employing gender- and age-sensitive strategies will significantly improve case detection. If these recommendations are not acted upon promptly, TB will persist as the primary cause of preventable illness and death among individuals living with HIV in Nigeria.

References

[1] Chukwuocha, I. K., Johnson, S.M. and Aguoru, E. P. (2023). Prevalence, profile and treatment outcome of tuberculosis-human immunodeficiency virus co-infection in South Eastern Nigeria: A 3-year retrospective study. *Nigerian Medical Journal*, 64(6), 789-798

[2] Gupta, A., Wood, R., Kaplan, R., Bekker, L. G., & Lawn, S. D. (2012). Tuberculosis incidence rates during 8 years of follow-up of an antiretroviral treatment cohort in South Africa: comparison with rates in the community. *PloS ONE* 7(3), e34156

[3] Hermans, S. M., Castelnuovo, B., Katabira, C., Mbidde, P., Lange, J. M., Hoepelman, A. I., ... & Manabe, Y. C. (2012). Integration of HIV and TB services results in improved TB treatment outcomes and earlier prioritized ART initiation in a large urban HIV clinic in Uganda. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 60(2), e29-e35

[4] Horton, K. C., MacPherson, P., Houben, R. M., White, R. G., & Corbett, E. L. (2016). Sex differences in tuberculosis burden and notifications in low-and middle-income countries: a systematic review and meta-analysis. *PLoS Medicine*, 13(9), e1002119

[5] Iwuoha, E. C. (2021). Prevalence and Knowledge of Tuberculosis among HIV Patients Accessing Care at Abia State University Teaching Hospital, Nigeria. *Asian Journal of Medical Principles and Clinical Practice*, 4(2), 243-248

[6] Kassa, A., Jerene, D., Assefa, Y., Teka, A., Aseffa, A., & Deribew, A. (2012). Evaluation of collaborative TB/HIV activities in a general hospital in Addis Ababa, Ethiopia. *BMC Research Notes*, 5(1), 67

[7] Kirenga, B. J., Ssengooba, W., Muwonge, C., Nakiyingi, L., Kyaligonza, S., Kasozi, S., ... & Okwera, A. (2015). Tuberculosis risk factors among tuberculosis patients in Kampala, Uganda: implications for tuberculosis control. *BMC Public Health*, 15(1), 13

[8] Kwaghe, A. V., Umeokonkwo, C. D., and Aworh, M. K. (2020). Evaluation of the national tuberculosis surveillance and response systems, 2018 to 2019: National Tuberculosis, Leprosy Buruli Ulcer control programme, Abuja, Nigeria. *Pan African Medical Journal*, 35, 54

[9] Lönnroth, K., Williams, B. G., Cegielski, P., & Dye, C. (2010). A consistent log-linear relationship between tuberculosis incidence and body mass index. *International Journal of Epidemiology*, 39(1), 149-155

[10] Lumu, I., Musaazi, J., Semeere, A., Handel, I., and Castelnuovo, B. (2023). Survival and predictors of mortality after completion of TB treatment among people living with HIV: a 5-year analytical cohort. *BMC Infectious Diseases*, 23(1), 238

[11] Meintjes, G. and Maartens, G. (2024). HIV-Associated Tuberculosis. *N Engl J Med.* 391(4), 343-355

[12] Melkamu, M. W., Gebeyehu, M. T., Afenigus, A. D., Hibstie, Y. T., Temesgen, B., Petrucka, P., and Alebel, A. (2020). Incidence of common opportunistic infections among HIV-infected children on ART at Debre Markos referral hospital, Northwest Ethiopia: a retrospective cohort study. *BMC Infectious Diseases*, 20(1), 50

[13] Nissapatorn, V., Lee, C., Ithoi, I., Yik, F. M., and Abdullah, K. A. (2003). Tuberculosis in AIDS patients. *The Malaysian Journal of Medical Sciences* 10(1), 60

[14] Nwoga, H. O., Igweagu, C. P., & Umeh, G. C. (2024). Prevalence and determinants of TB/HIV coinfection: the double tragedy of infectious disease burden–a 5-year retrospective study in a tertiary health facility in Enugu State, Nigeria. *BMJ Open*, 14(11), e088287

[15] Ochonye, B., Sanni, F. O., Emmanuel, G., Umoh, P., Kalaiwo, A., Abang, K., Amechi, P., Ahkigbe, M., Akinpelumi, S. and Motilewa, O. (2024). A retrospective study of tuberculosis prevalence and HIV/TB co-infection among key populations in Nigeria. *PLOS Global Public Health,* 4(10), e0003461

[16] Pawlowski, A., Jansson, M., Sköld, M., Rottenberg, M. E., and Källenius, G. (2012). Tuberculosis and HIV co-infection. *PLoS Pathogens*, *8*(2), e1002464

[17] Rangaka, M. X., Wilkinson, R. J., Boulle, A., Glynn, J. R., Fielding, K., Van Cutsem, G., ... & Maartens, G. (2014). Isoniazid plus antiretroviral therapy to prevent tuberculosis: a randomised double-blind, placebo-controlled trial. *The Lancet*, 384(9944), 682-690

[18] Range, N., Ipuge, Y., Obrien, R., Egwaga, S., Mfinanga, S., Chonde, T., ... & Borgdorff, M. W. (2001). Trend in HIV prevalence among tuberculosis patients in

Tanzania, 1991–1998. *The International Journal of Tuberculosis and Lung Disease*, 5(5), 405-412

[19] Suthar AB, Lawn SD, del Amo J, Getahun H, Dye C, Sculier D, Sterling TR, Chaisson RE, Williams BG, Harries AD, Granich RM. (2012). Antiretroviral therapy for prevention of tuberculosis in adults with HIV: a systematic review and meta-analysis. *PLoS Med* 9(7), e1001270

[20] Tesfaye, B., Alebel, A., Gebrie, A., Zegeye, A., Tesema, C., and Kassie, B. (2018). The twin epidemics: Prevalence of TB/HIV co-infection and its associated factors in Ethiopia; A systematic review and meta-analysis. *PloS ONE* 13(10), e0203986