Nigerian Medical Journal
NIGERIA MEDICAL ASSOCIATION
Print ISSN 0300-1652, E-ISSN 2229-774X

Original Article

Prevalence, Profile and Treatment Outcome of Tuberculosis-Human Immunodeficiency Virus Co-Infection in South Eastern Nigeria: A 3-Year Retrospective Study

***Ikechukwu kelechukwu Chukwuocha[1], Simon Mafuka Johnson[2], Ezinne Pamela Aguoru[1].**

[1]Federal University Teaching Hospital Owerri, Owerri, Nigeria, [2]Department of Internal Medicine, Federal University Teaching Hospital Owerri, Owerri, Nigeria.

DOI: https://doi.org/10.60787/nmj-64-6-372

Abstract

Background: Tuberculosis (TB) and the Human Immune Deficiency Virus (HIV) represent major public health challenges and are intricately linked to each other. This is more prevalent in the sub-Saharan African region, where about 80% of this co-infection is recorded. This study aimed to review the prevalence, profile, and treatment outcome of TB-HIV co-infected patients.

Methodology: A hospital-based retrospective study was conducted in a tertiary center in southeast Nigeria for the period 2015–2017. Information elicited from participant's medical records included socio-demographic profile (age, sex, residential area, and occupation), Cluster of Differentiation 4 (CD4) count level at the time of diagnosis of co-infection, weight, treatment outcome, as well as the record of the number of TB patients who presented within this same period.

Results: The total number of TB/HIV co-infected patients who participated in the study during this period was 207, with a prevalence of TB/HIV co-infection of 33.9%. The highest proportion of cases was recorded among participants within the age group of 31–40, and the cases of co-infection were more common in males (58.9%) and students (27.5%). The results also showed a significant relationship between gender, occupation, residential area, and TB/HIV co-infection. Most of the co-infected participants had a CD4 count of <300 cells/mm3 and an associated poor treatment outcome of 41.1%.

Conclusions: TB/HIV co-infection needs to be properly addressed, and screening for HIV among TB patients should be a priority. This will help in early diagnosis and subsequently improve the treatment outcome of both diseases.

Keywords: tuberculosis, HIV, Co-Infection, Nigeria

***Correspondence:** **I**kechukwu kelechukwu Chukwuocha, Federal University Teaching Hospital Owerri, Nigeria.
Email: iyke.chukwuocha@gmail.com
How to cite: Chukwuocha IK, Simon JM, Aguoru EP. Prevalence, Profile and Treatment Outcome of tuberculosis-Human immunodeficiency Virus co-infection in South-Eastern Nigeria: A 3-year retrospective study. Niger Med J 2024; 64 (6):789 - 798

Quick Response Code:

Introduction

Tuberculosis (TB) associated with the human immunodeficiency virus (HIV) continues to be a significant global public health challenge. Globally, TB kills more than 5000 people per day while HIV kills more than 8000 people. [1] According to WHO (2022), TB affects an estimated one-third of the world's population, while HIV affects an estimated 35 million people, with 2.1 million new cases. A total of 1.3 million died from TB including 167 people living with HIV/AIDS in 2022. [2] According to the World Health Organization, 39% of newly diagnosed cases of tuberculosis (TB) are thought to be caused by HIV infection, with an approximate 14 million people worldwide having both infections.[1] In people with HIV infection, tuberculosis continues to be the most prevalent opportunistic infection (OI), accounting for about 26% of AIDS-related deaths. With a 20–30 times higher lifetime risk of developing TB in HIV-positive patients compared to HIV-negative patients.[3] The co-infection burden is disproportionately heavy in Sub-Saharan Africa, especially in Nigeria where the health system is already underdeveloped and stretched thin, raising serious concerns about this double epidemic of TB and HIV.[4] Whether or not, the organism is sensitive and responsive to anti-TB medications, the risk of death from TB is appreciably higher in the HIV-infected population.[5] In co-infected patients, the relationship between HIV and TB is bidirectional and synergistic, with HIV predisposing to the development of active TB and active TB infection worsening the course of HIV-related immunodeficiency. [6,7]

HIV co-infection and tuberculosis present unique diagnostic and therapeutic challenges. Drug-resistant tuberculosis rates, including multi- and extensively drug-resistant TB, have increased. These cases are challenging to treat and have a higher mortality rate.[8] Furthermore, recent scientific studies have demonstrated that by providing integrated TB-HIV care, we can avoid a million deaths among PLWHAS. Given that TB-HIV co-infection has a significant negative impact on Nigeria. [9]

To create evidence-based interventions for patients and at-risk populations, the study sought to assess the prevalence, profile, and treatment outcomes linked to TB-HIV co-infection. Due to notable research void in this field in Nigeria. This study sought to answer the following research questions: What is the prevalence of TB-HIV co-infection? What is the clinical-sociodemographic profile of these TB-HIV co-infected patients? What is the treatment outcome of these patients as carried out in a tertiary center in South-Eastern Nigeria?

Considering this significant research gap that is especially prevalent in this region. The results of this study will give insight into TB-HIV co-infection in the nation and inform policymakers, activists, and health professionals working in the area about TB-HIV control, allowing them to create evidence-based interventions for tackling this major public health issue in the nation.

Methodology

Study setting: the study was carried out in a tertiary hospital (Federal Medical Centre) in 0werri Imo State Nigeria, which is a major referral center for most hospitals in Imo State and its environs. It’s located in the heart of the town (Owerri municipal local government council of Imo state).

Study design, period, participants, and data source: this is a retrospective cross-sectional study based on a review of the medical records of TB-HIV co-infected patients on anti-tuberculosis treatment in the

Federal Medical Centre Owerri now (Federal University Teaching Hospital) between January 2015 and December 2017the facility-based TB register and health records, which are standard records stored by the healthcare facility, were used for data extraction. These were then entered into Microsoft Office Excel and password protected.
Bias: the register's ambiguous and unclear information was not included in the analysis. To ensure data validity, Information that didn't provide proof of a diagnosis was removed. Information on patient demographics, disease classifications, sputum microscopy, GeneXpert, HIV status, CD4 count, weight of patients, and treatment outcomes of TB-HIV co-infected cases were collected.

Statistical methods/analysis: data extracted from the health records were entered into Microsoft Office Excel. The data was cleaned and subsequently entered the SPSS software version 21 for analysis. The outcome variable was TB–HIV co-infection treatment outcome whereas the predictor variables were age, sex, place of residence occupation, CD4 count, and weight profile of patients. The univariable descriptive statistics, including mean, SD, percentages, and frequencies, were presented in tables and graphs. The association between TB–HIV co-infection and the clinico-demographic variables was examined using a chi-square and linear regression. The criterion for significance was set with $P < 0.05$ at 95% confidence interval (CI).

Ethical consideration: The Federal University Teaching Hospital Owerri's Ethical Review Committee reviewed and approved the study. Additionally, consent from the heads of the TB treatment units was obtained before reviewing the medical records of the patients who were also co-infected with HIV and TB. The study's results were kept confidential, and the data was only used for that purpose. Since privacy and anonymity were upheld and the data were gathered by reviewing medical records, there was no danger to the patients or their families. Additionally, the data collection form did not include any personal identification information, and only the principal investigators had access to the recorded data.

Study measures: The socio-demographic characteristics (sex, age, place of residence (rural/urban) and occupation), CD4 count level, weight profile, Treated/Cured (Previously smear-positive patients that were smear-negative during the treatment and have completed treatment), Died and Others (defaulters, transfer out, treatment relapse or lost to follow up)

Definitions of treatment outcome
In line with the guidelines for the National Tuberculosis and Leprosy Control Program (NTLCP)[10] and the 2013 revision to the WHO Definitions and reporting framework for tuberculosis.[11] Treatment outcome definitions] were as follows:

Cured: A pulmonary TB patient who was smear- or culture-negative in the month before treatment ended and at least once previously and who had TB that was bacteriologically confirmed at the start of treatment.
Died: A TB patient who passes away for any reason before starting treatment or while on it
Treatment failure: a TB patient who is receiving treatment and has a positive sputum culture or smear after five months or more. Patients who, whether they are smear-negative or smear-positive, are discovered to be carrying a multidrug-resistant (MDR) strain at any point during the course of treatment.
Defaulters/Transferred out/ Treatment relapse: a patient with TB for whom no treatment outcome has been determined.

Inclusion criteria: TB patients aged 18 and above who tested positive for HIV and patients with HIV receiving TB treatment.

Exclusion criteria: incomplete record

Results

Prevalence of TB-HIV coinfection of study participants: In this study, a total of 610 study participants' clinical records were reviewed. Out of this number 207/610 (33.9%) were coinfected with TB and HIV.

Socio-demographic characteristics of study participants: among the co-infected subjects 122(58.9%) were males and 85 (41.1%) were females. The majority 72 (34.8%) of HIV-infected TB patients belonged to the age group of 31-40 years, this was followed closely by patients in the age group of 21-30 years at 56(27.1%). A large proportion of TB/HIV patients belong to the student group which constituted 57(27.5%). The proportion of patients residing in the rural areas was found to be higher than the urban dwellers at 118(57.3%) and 89(42.9%) respectively. With regard to occupation, the highest proportion of TB/HIV co-infected cases was found to be students at 57(27.5%) which was followed closely by traders and civil servants at 37(17.9%) and 29 (14%) respectively.

Table 1: Socio-demographic profile of TB/HIV Patients Who presented Between 2015 and 2017

		n (207)	%	X2	P
Gender				57.381	.000*
	Male	122	58.9		
	Female	85	41.1		
Age				13.046	.221
	<20	29	14		
	21-30	56	27.1		
	31-40	72	34.8		
	41-50	28	13.5		
	51-60	17	8.2		
	61-70	5	2.4		
	>70	-	-		
Residence				61.139	.000*
	Rural	118	57.1		
	Urban	89	42.9		
Occupation				92.753	.000*
	Civil Servants	29	14		
	Drivers	12	5.8		
	Farmers	14	6.8		
	Housewives	17	8.2		
	Student	57	27.5		
	Traders	37	17.9		
	Unemployed	16	7.7		
	Artisans	20	9.7		
	Others	5	2.4		

*Denotes p-value <=0.05

The clinical profile of study participants: The available CD4 count profile of study participants showed that of the total of 193 TB/HIV co-infected patients whose CD4 count results were available during the

course of the study, 106(54.4%) had CD4 count <300ells/mm^3 while 88(45.6%) had CD4 count between 300-500, none of the patients had a CD4 count of above 500 cells/mm$^{3.}$

Table 2: CD4 count profile of TB/HIV Patients Who presented Between 2015 and 2017

CD4 COUNT LEVEL (Cells/mm^3)	n (193)	%
≥ 300	88	45.6
<300	106	54.4
TOTAL	193	
MISSED	14	

The available Weight profile of study participants revealed a total of 59 TB/HIV of co-infected patients presented in 2015 with a mean weight of 50.27kg with an upper boundary of 52.93kg and a lower limit of 47.2kg. of the 79 patients in the year 2016, the mean weight was noted to be 43.18kg with the upper and lower limit of 46.5kg and 39.98kg while the year 2017 showed that of a total of 69 TB/HIV co-infected patients, the mean weight was 50.27kg with an upper and lower limit of 55.01kg and 48.89kg respectively.

Table 3: Weight Profile of TB/HIV Co-infected Patients who presented between 2015 and 2017.

YEAR	LOWER LIMIT	MEAN WEIGHT (kg)	Std deviation	UPPER LIMIT
2015 (n=59)	47.2	50.27	11.15	52.93
2016 (n=79)	39.98	43.18	14.01	46.3
2017 (n=69)	48.89	51.95	11.74	55.01

Treatment outcome and success rate of study participants: of the 207 TB/HIV co-infected patients who presented between 2015-2017, treatment success rate was recorded in 85(41.1%) of them while 22(10.6%) died within the course of the illness. A total of 100(48.3%) patients were in the others (defaulters, transfer out, and treatment relapse) category.

Table 4: Treatment Outcome of TB/HIV Patients Who presented Between 2015 and 2017

TREATMENT OUTCOME	n (207)	%
TREATED/CURED	85	41.1
DIED	22	10.6
OTHERS (DEFAULTER, TRANSFER OUT, TREATMENT FAILURE/ RELAPSE)	100	48.3

Discussion

This study investigated the prevalence, socio-demographic profile, CD4 Count level, weight profile, and treatment outcome of patients co-infected with TB/HIV infection in Federal Medical Centre Owerri a tertiary institution in south-eastern Nigeria.

Of the 6l0 TB patients, 207 were co-infected with TB/HIV showing a prevalence of 33.9%. The high prevalence of HIV/AIDS disease among TB patients attending care and treatment in this setting suggests a strong relationship between TB and HIV infection in this area. The findings obtained from this study are in consonance with some reports from other parts of this country and beyond. In a study conducted in Lafia, central Nigeria the prevalence of TB/HIV co-infection was 34.5%, 30% in Plateau state, Nigeria. Also, a study in Kenya in Dabat-Gondar showed a prevalence of 34% and 36%.[10,7] Additionally a recent systematic review conducted in Nigeria has shown that the southeastern part of the country has the lowest prevalence of TB-HIV coinfection.[11] This prevalence is higher than reported cases in some parts of Nigeria by 20% and Ethiopia at 24.3%[12, 13] This might be due to overlapping co-morbid diseases in the study area like diabetes mellitus, high TB detection rate as a result of the availability of TB diagnostic facilities in the center where the study was carried out or because the study was conducted in a referral hospital where many chronic end organ diseases present, which might be responsible for the high prevalence of TB/HIV. Additionally, the people in this area consume a lot of alcohol which may lead to an increase in risk behaviours.[14] Furthermore, the lack of implementation of isoniazid preventive therapy in HIV-positive individuals at risk of TB might also have contributed to the higher prevalence of TB/HIV co-infection. In contrast, the prevalence of TB/HIV co-infection in this study was found to be lower than recorded in studies done in bebre markos which showed 64% [15] and in Kenya[16.]

Our study showed a significant association between gender, occupation, and residential area to TB/HIV co-infection. A p-value of <0.05. Furthermore, this study also revealed that the highest proportion of TB/HIV co-infection was found among male patients at 58.9% while females at 41.1%, this is similar to a study conducted in Dabat, Ethiopia, Northwest Ethiopia, and Sao Paolo.[13,17,18] This can be attributed to the fact that males are economically more active and influential in the community and they are more likely to smoke and drink which increases risk behaviours like having multiple sexual partners than female folks.

The study also revealed that the highest proportion of TB/HIV co-infection was found among patients in the age range of 31-40 years old, followed closely by 21-30 years old, this was similar to a study conducted in Debre-markos referral hospital.[16] The fact that these age groups are more sexually active and are likely to be involved in other high-risk behaviours such as drinking and smoking which can lead to increased vulnerability to HIV infection and thus TB co-infection when compared to another age group may have contributed to this finding. The occupational profile of our patients showed that the highest proportion of the patients was found among traders followed by students This might be attributed to the fact the proximity of traders in the market area and the close association of students living in the hostels might make it easier for the transmission of tubercle bacilli in this setting. Other authors found that the seropositivity rate was highest among the unemployed and business professionals.[19]

The study found that the level of CD4 count of the patients was all lower than the normal CD4 count, at less than 500 cells/mm3 this might have contributed to the poor treatment outcome recorded in this study. Some studies have associated low CD4 T cell count with increasing mortality in this patient population.[20] Though our study demonstrated that TB-HIV co-infection can be seen regardless of the level of CD4 count more frequently at a CD4 count of = or < 300cells/mm3 which was a similar finding in studies done by Ngowi and wondimeneh.[21,22] In this study the weight profile of our patients was below the normal weight for an adult male which is approximately 70kg and is likely a result of undernutrition weakening the immune system and increasing reactivation of latent TB. Similar findings were also noted in a report by Mupereand Hanvalan. [23,24] were low body mass index and weight was significantly associated with TB infection.

This study showed that the treatment outcome of tuberculosis in HIV-positive patients was 41.1%. this was lower than the treatment success rate obtained in some other studies[25]This finding was lower than the national Tuberculosis treatment success rates of 2013 (89%) [26] and the rate recommended by WHO.[27] One of the reasons could be that immunosuppression of HIV patients makes them vulnerable to getting active TB and its consequent rapid progression. Co-administration of ART therapy can lead to drug-drug interaction, overlapping drug toxicities, and immune reconstitution syndrome which will adversely affect the treatment outcome. It could also be a result of late HIV diagnosis by which time immunosuppression has progressed, poor patient adherence to treatment, and defaulting on treatment by some patients which could be a result of stigma against people living with the disease may have contributed to poor treatment outcome. A study done in India showed a lower cure rate of 16.09%.[29]The high percentage of treatment failure reported was due to loss of follow-up and death. Similarly, other studies demonstrated the rate of unsuccessful treatment outcomes to result from loss of follow-up and death due to the incapacitation of TB patients occasioned by the multi-drug resistant strains of *M. tuberculosis*[29,30]

Conclusion

HIV infection has contributed to the burden of TB in this region. The proportion of TB/HIV co-infection was quite high and associated more with males and individuals in the economically productive age group (21-40), majority of the patients belong to the student category followed closely by traders. There was associated poor treatment outcome of HIV/TB co-infection in this region at 41.1% which is much lower than the WHO recommended target of control which is >85%.

Limitations of the study: this study gathered information from secondary data that cannot be evaluated for various factors that might serve as a confounder to the treatment outcomes of patients who are co-infected with TB and HIV. Additionally, records with missing values that could underestimate or underestimate the treatment outcome were excluded from this study which may impact the study population over the given period.

What is known about this Topic?

The co-infection burden is disproportionately heavy in Sub-Saharan Africa, especially in Nigeria where the health system is already underdeveloped and stretched thin, raising serious concerns about this double epidemic of TB and HIV.

The risk of dying from TB is noticeably higher in the HIV-infected population, regardless of whether the organism is sensitive and responsive to anti-TB medications.

HIV predisposes to the development of active TB, and active TB infection worsens the course of HIV-related immunodeficiency. This relationship between HIV and TB in co-infected patients is bidirectional and synergistic.

What this study adds

The results of this study will give insight into the extent of TB-HIV co-infection in the nation.

The findings of this study will help educate policymakers, activists, and local health professionals about TB-HIV control, enabling them to develop evidence-based interventions for addressing this significant public health issue in the country.

The results of this study can be used as a foundation for developing and carrying out additional ecological studies within and outside of this region.

Recommendations

Across the nation, studies to reveal patterns in co-infection with HIV and TB should be conducted.
All TB cases must be tested for HIV to identify TB/HIV early and treat it effectively.

To prevent treatment interruptions, home visits are offered, patients are encouraged, defaulter tracing is enhanced, and health information is dispersed.

Public education and awareness campaigns through various interventions ought to be welcomed and stepped up, particularly in our regions with high rates of TB and HIV. This will assist in preventing and controlling the dual infection, which poses a significant challenge to our overstretched healthcare system.

Competing interest

We declare no competing interest.

Authors contribution

Ikechukwu Kelechukwu Chukwuocha, Simon Mafuka Johnson, and Ezinne Pamela Aguoru contributed to designing the study, data collection, analysis, interpretation, and write-up.

Simon Mafuka Joseph: The manuscript was revised thoroughly by him. The final manuscript was read and approved by all authors.

Acknowledgments

We express our deep appreciation to the Federal University Teaching Hospital Owerri and the heads of the TB treatment units and workers of the TB treatment Unit.

Funding: This research was personally funded and received no funding grant from any group

References

1. WHO. Global Tuberculosis (TB) Report [Internet]. [cited 2023 Nov 2023]. Available from: https://www.who.int/news-room/fact-sheets/detail/tuberculosis

2. WHO. Global HIV & AIDS statistics — Fact sheet | UNAIDS [Internet]. [cited 2023 Jul 17]. Available from: https://www.unaids.org/en/resources/fact-sheet

3. Nissapatorn V, Lee C, Ithoi I, Yik FM, Abdullah KA. Tuberculosis in AIDS patients. Malays J Med Sci. 2003;10(1):60-4.

4. Sabine MH, Barbara C, Catherine K, Peter M, Joep MA, Andy IMH et al, 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. -J Acquir Immune Defic Syndr. 2012;60(2):e29-35.

5. Lumu I, Musaazi J, Semeere A, Handel I, Castelnuovo B. *et al.* Survival and predictors of mortality after completion of TB treatment among people living with HIV: a 5-year analytical cohort. *BMC Infect Dis* 2023;**23**, 238.https://doi.org/10.1186/s12879-023-08217-9

6. Pawlowski A, Jansson M, Sköld M, Rottenberg ME, Källenius G. Tuberculosis and HIV Co-Infection. PLoS Pathog 2021;8(2): e1002464. https://doi.org/10.1371/journal.ppat.1002464

7. Tesfaye B, Alebel A, Gebrie A, Zegeye A, Tesema C, Kassie B. The twin epidemics: Prevalence of TB/HIV co-infection and its associated factors in Ethiopia; A systematic review and meta-analysis. PLoS One. 2018;13(10):e0203986. doi: 10.1371/journal.pone.0203986.

8. Seung KJ, Keshavjee S, Rich ML. Multidrug-Resistant Tuberculosis and Extensively Drug-Resistant Tuberculosis. Cold Spring Harb Perspect Med. 2015 Apr 27;5(9):017863. doi: 10.1101/cshperspect.a017863. PMID: 25918181; PMCID: PMC4561400

9. Adejumo OA, Daniel OJ, Otesanya AF, Adegbola AA, Femi-Adebayo T, Bowale A, et al. Factors associated with HIV/TB co-infection among drug-sensitive tuberculosis patients managed in a secondary health facility in Lagos, Nigeria. Afr J Infect Dis. 2017 Jun 8;11(2):75–82.

10. Reuben R, Gyar s. D, Dauda E. Prevalence of Tuberculosis in HIV/AIDS Patients in Lafia, Central Nigeria. International Journal of Current Microbiology and Applied Sciences. 2014;27;3:831–8.

11 Reward EE, Ike AC, Muo SO, Soga-Oke BF, Mbaawuaga EM. Coinfection of Tuberculosis and HIV in Nigeria: A Systematic Review and Meta-analysis. AIDS Rev. 2020;23(2):82-90. doi: 10.24875/AIDSRev.20000068.

12. Ugwu KO, Agbo MC, Ezeonu IM. prevalence of tuberculosis, drug-resistant tuberculosis, and HIV/TB co-infection in Enugu, Nigeria. Afr J Infect Dis. 2021;15(2):24–30.

13. Tadesse S. HIV co-infection among tuberculosis patients in Dabat, Northwest Ethiopia. J Infect Dis Immun. 2013;5(3):29–32.

14. Nwosu IA, Ekpechu J, Njemanze VC, Ukah J, Eyisi E, Ohuruogu B, et al. Self-Report on Men's Beliefs and Perceptions on Their Alcohol Use/Misuse in Southeast Nigeria. Am J Mens Health. 2022;16(6):15579883221130193.

15. Bruchfeld J, Correia-Neves M, Källenius G. Tuberculosis and HIV Coinfection. Cold Spring Harb Perspect Med. 2015;5(7):a017871. doi: 10.1101/cshperspect.a017871.

6. Mekonnen D, Derbie A, Desalegn E. TB/HIV co-infections and associated factors among patients on directly observed treatment short course in Northeastern Ethiopia: a 4 years retrospective study. BMC Res Notes. 2015;8:666.

17. Belay M, Bjune G, Abebe F. Prevalence of tuberculosis, HIV, and TB-HIV co-infection among pulmonary tuberculosis suspects in a predominantly pastoralist area, northeast Ethiopia. Glob Health Action. 2015;8:10.3402/gha.v8.27949.

18. Tancredi MV, Sakabe S, Waldman EA. Mortality and survival of tuberculosis coinfected patients living with AIDS in São Paulo, Brazil: a 12-year cohort study. BMC Infect Dis. 2022;22:223.

19. Patel AK, Thakrar SJ, Ghanchi FD. Clinical and laboratory profile of patients with TB/HIV coinfection: A case series of 50 patients. Lung India. 2011;28(2):93–6.

20. Hoffmann CJ, Schomaker M, Fox MP, Mutevedzi P, Giddy J, Prozesky H, Wood R, Garone DB, Egger M, Boulle A; IeDEA Southern Africa Collaboration. CD4 count slope and mortality in HIV-infected patients on antiretroviral therapy: multicohort analysis from South Africa. J Acquir Immune Defic Syndr. 2013;63(1):34-41. doi: 10.1097/QAI.0b013e318287c1fe.

21. Ngowi BJ, Mfinanga SG, Bruun JN, Morkve O. Pulmonary tuberculosis among people living with HIV/AIDS attending care and treatment in rural northern Tanzania. BMC Public Health. 2008;8(1):341.

22. Kesari SP, Basnett B, Chettri A. et al Spectrum of Tuberculous Infection in Patients Suffering from HIV/AIDS and Its Correlation with CD-4 Counts: A Retrospective Study from Sikkim. Indian J Otolaryngol Head Neck Surg. 2019;71(2):167–71.

23. Agbor AA, Bigna JJR, Plottel CS, Billong SC, Tejiokem MC, Ekali GL, et al. Characteristics of patients co-infected with HIV at the time of inpatient tuberculosis treatment initiation in Yaoundé, Cameroon: a tertiary care hospital-based cross-sectional study. Archives of Public Health. 2015;73(1):24.

24. Musa BM, Musa B, Muhammed H, Ibrahim N, Musa AG. Incidence of tuberculosis and immunological profile of TB/HIV co-infected patients in Nigeria. Ann Thorac Med. 2015;10(3):185–92.

25. Weldegebreal F, Mitiku H, Teklemariam Z. Treatment outcome of tuberculosis among Human Immunodeficiency Virus positive patients in Eastern Ethiopia: a retrospective study. Pan Afr Med J. 2018;30:32. doi: 10.11604/pamj.2018.30.32.12554.

26. Danlami MB, Basiru A, Tajjudeen Y, Bazata AY, Gulumbe BH, Mohammed M. Tuberculosis treatment outcomes among pulmonary TB patients attending public hospitals in Kebbi State, Northern Nigeria: a four-year retrospective study. Bull Natl Res Cent2022;46(1):281. doi: 10.1186/s42269-022-00969-9.

27. Chaulk CP, Kazandjian VA. Directly observed therapy for treatment completion of pulmonary tuberculosis: Consensus Statement of the Public Health Tuberculosis Guidelines Panel. JAMA. 1998 Mar 25;279(12):943-8. doi: 10.1001/jama.279.12.943. Erratum in: JAMA 1998 Jul 8;280(2):134.

28. Selimin DS, Ismail A, Ahmad N, Ismail R, Mohd Azman NF, Azman A. Tuberculosis Treatment Outcome in Patients with TB-HIV Coinfection in Kuala Lumpur, Malaysia. J Trop Med 2021;2021:9923378. doi: 10.1155/2021/9923378.

29. Oshi D, Chukwu J, Nwafor C, Chukwu NE, Meka AO, Anyim M, et al. Support and unmet needs of patients undergoing multidrug-resistant tuberculosis (MDR-TB) treatment in southern Nigeria. Int J Health Plann Manage. 2020;35(4):832–42.

30. Eshetie S, Gizachew M, Alebel A, van Soolingen D. Tuberculosis treatment outcomes in Ethiopia from 2003 to 2016, and impact of HIV co-infection and prior drug exposure: A systematic review and meta-analysis. PLoS One. 2018;13(3):e0194675.