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Prevalence and Mortality Associated with Tuberculosis Among HIV-Infected Patients in High-Volume HIV Care Sites in Conakry

Niouma Nestor Leno[1, 2, 3, *], Foromo Guilavogui[2, 3], Mohamed Diallo[3], Aboubacar Sidiki Magassouba[1], Youssouf Koita[3], Laye Kaba[3], Souleymane Chaloub[4], Andre Kamano[4], Alexandre Delamou[1, 2], Alioune Camara[1, 2]

[1]Department of Public Health, Faculty of Health Sciences and Techniques, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

[2]African Center of Excellence for Prevention and Control of Communicable Diseases (CEA-PCMT), Faculty of Health Sciences and Techniques, Gamal Abdel Nasser University of Conakry, Conakry, Guinea

[3]National AIDS and Hepatitis Control Program, Conakry, Guinea

[4]NGO Doctors Without Borders of Belgium, Conakry, Guinea

Email address:

nnleno81@gmail.com (Niouma Nestor Leno)

[*]Corresponding author

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Abstract: *Introduction*: The objective of this study was to estimate the prevalence of tuberculosis and to identify factors associated with its occurrence among HIV-infected patients on antiretroviral therapy. It also estimated the survival rate among HIV patients co-infected with TB and among HIV patients not co-infected with TB. *Methods*: In this study, two types of studies were used. An analytical cross-sectional study was used to estimate the prevalence of TB at the time of data collection or extraction among HIV-infected patients. A historical cohort study was used to analyze the survival of HIV patients on ART at different time points during their follow-up. We used Kaplan Meir survival analysis techniques to estimate the cumulative incidence of death among patients on antiretroviral therapy at different follow-up periods. We used multivariate logistic regression to identify associations significantly associated with the occurrence of TB in patients living with HIV. *Results*: The prevalence of tuberculosis among HIV-infected patients was 21.19%. The cumulative probability of death for patients on ART was 6.80%, or an incidence rate of 3.27 per 100 person-years. The advanced clinical stage of HIV infection at ART initiation, the low CD4 count at ART initiation, and the high viral load at ART initiation were statistically associated with the occurrence of TB in HIV-infected patients (all AOR > 1, p-value < 0.05). *Conclusion*: This study showed that the cumulative probability of death was higher in patients co-infected with HIV and TB than in those who were not. A mixed study (a prospective quantitative component and a qualitative component) could allow a better understanding of this phenomenon of tuberculosis occurrence among HIV-infected patients in Guinea.

Keywords: HIV, Tuberculosis, Co-infection, Prevalence, Mortality, Guinea

1. Introduction

Tuberculosis is the most common opportunistic infection among people living with HIV around the world [1] and in Africa [2]. It is the first revealing sign in the majority of AIDS cases, including in patients on ARTs [1]. Tuberculosis (TB) is also a leading cause of death among HIV-infected people, accounting for up to 11% of AIDS-related deaths worldwide [3].

TB-HIV co-infection is a major public health problem in

many parts of the world [4]. It constitutes a major and pejorative association; one even speaks about murderous couple or diabolic duo [2]. It is also associated with particular diagnostic and therapeutic challenges and places a huge burden on the health systems of highly infected countries [5].

The World Health Organization (WHO) estimated that of the 10 million patients diagnosed with TB around the World in 2017, 9% were co-infected with HIV [6]. Of these 71% lived in Africa [7].

Nearly 60% of TB cases among people living with HIV (PLHIV) are undiagnosed or untreated, resulting in 390,000 TB-related deaths. Sub-Saharan Africa bears the burden of the dual epidemic [2], accounting for approximately 84% of all HIV-associated TB deaths in 2018 [8].

However, the main factors associated with the occurrence of TB among patients living with HIV were: Black race, low weight: < 50 Kg, male gender, low body mass index: BMI < 18.5 kg/m2 [1, 4, 9, 10], history of tuberculosis [11–13], low Cd4 count: < 200, WHO advanced clinical stage: high viral load and high viral load [4, 14, 15].

In order to reduce the incidence of TB infection among PLHIV, WHO recommends the three I's strategy: intensive case finding, isoniazid preventive therapy and infection control at all clinical appointments. PLHIV who are likely to have active TB should receive at least 6 months of IPT as part of a comprehensive HIV care package. However, less than 5% of people living with HIV in care receive it [8].

According to a systematic review and meta-analysis of the global prevalence of HIV/TB and/or TB/HIV co-infection in countries (excluding China) in 2013, the prevalence of co-infection in African countries was higher than in the rest of the world at 31.2%. It was 17.21% in Asian countries, 20.11% in European countries, 25.06% in Latin American countries and 14.84% in the United States [16].

In Brazil, according to a 2014 study, the prevalence of TB-HIV co-infection was 19% among adults [9] while it was 12.9% in Cambodia [17]. In China, the overall prevalence of TB infection among HIV-positive people is estimated at 7.2% and is even higher at 22.8% among AIDS patients [18]. Another systematic review on prevalence in sub-Saharan Africa reported that the overall estimate of HIV prevalence among TB patients was 31.8% with substantial heterogeneity in prevalence estimates in southern, central, eastern, and western sub-Saharan Africa (43.7, 41.3, 31.1, and 25.5%, respectively) [7]. In Sudan the prevalence of co-infection was 33% [14]. In Senegal, TB/HIV prevalence was 10% [2].

In Ivory Coast, the prevalence of TB-HIV co-infection is estimated at 9.05% among the elderly, compared with 44.38% in the case of tuberculosis in subjects under 65 years of age [19].

In Guinea, HIV prevalence among TB patients has been around 25% since 2010 according to the National Tuberculosis Control Program, while the incidence of TB/HIV co-infection is estimated at 43 (28-62) cases per 100,000 inhabitants by WHO in 2018 [20]. There is a lack of availability of recent published data on the occurrence of TB in HIV-infected patients in the national AIDS program in Guinea. However, this information is crucial for the evaluation of the performance of the AIDS program and for the regular readjustment of interventions for the control and management of TB/HIV co-infection. It should be noted, however, that the old data available on co-infection at the level of the AIDS control program are global data, not including aspects of etiological analysis to identify the factors associated with the occurrence of TB among HIV-infected people in Guinea. For this reason, we thought it would be useful to conduct this study, which aims was to estimate the prevalence of tuberculosis and to identify factors associated with its occurrence among HIV-infected patients on antiretroviral therapy. It also estimated the survival rate among HIV patients co-infected with TB and among HIV patients not co-infected with TB.

2. Methods

2.1. Setting

We conducted this study in high-volume sites of care for people living with HIV in Guinea. In Guinea, a site is considered a high-cohort site when the number of people on ART it manages equals or exceeds 250. In 2019, there were 29 sites out of 142 that met this definition and managed more than 90% of all patients on ART in the country [13]. The present study focused on 9 high-volume sites, which has the electronic tools for longitudinal data management of patients on ART. Eight of these sites are located in Conakry (Communal Medical Center of Matam, Communal Medical Center of Flamboyants, Communal Medical Center of Coleah, Communal Medical Center of Miniere, Health Center of Wanindara, Health Center of Tombolia, Health Center of Gbessia Port 1 and Health Center of Dabompa) and one is located in remote area from Conakry (Regional Specialized Medical Center of Macenta of the Philafrican Mission). These eight sites technically supported by the NGO Doctors Without Borders Belgium, are public sites. The site supported by Philafrican Mission is private site [14]. In Republic of Guinea, the World Health Organization's recommendation "Test - Treat" has been applied since 2017 in terms of antiretroviral treatment for people living with HIV [15]. The antiretroviral treatment administered to people living with HIV/AIDS is a triple therapy usually combining two nucleotide reverse transcriptase inhibitors (NRTIs) and a non-nucleotide reverse transcriptase inhibitor (NNRTI) or a protease inhibitor (PI) or an integrase inhibitor (IG). Fixed-dose combinations are preferred to promote adherence and reduce the cost of care for the country. However, some patients are on second and third line antiretroviral therapy.

2.2. Study Design and Data Sources

In this study, two types of studies were used. An analytical cross-sectional study was used to estimate the prevalence of TB at the time of data collection or extraction among HIV-infected patients. A historical cohort study was used to

analyze the survival of HIV patients on ART at different time points during their follow-up. The data were extracted from the "TIER. NET" databases managed by NGO Doctors Without Borders of Belgium and exported to an Excel file. The data of Regional Specialized Medical Center of Macenta were extracted from the AVICEMA database managed by PhilAfrican Mission.

2.3. Study Population and Sample Size

The study population consisted of HIV-positive adolescent (10-14 years old) and adult (males and females 15 years and older) patients who were confirmed to be HIV-positive and started ART during the period April 1, 2015, to March 31, 2020, with at least 6 months of follow-up before the date of data extraction. In this study we excluded:

1) patients listed as having initiated ART during the study period and whose ART initiation date is unknown;
2) patients whose age of ART initiation is unknown;
3) patients who left the cohort and whose last appointment and/or event dates (lost to follow-up and death) are not known.

We conducted an exhaustive sampling of patients who met the inclusion criteria for this study. A total of 14 373 patients were obtained for the different analyses.

2.4. Description of Variables

Variables extracted for retention and attrition analysis included sociodemographic characteristics, clinical and therapeutic characteristics, Cd4 biomarkers, viral load), TB/HIV co-infection status and patient follow-up status (followed up, lost to follow-up, died, and transferred).

2.5. Outcomes Measurement

1) *TB/HIV co-infection*: all patients living with HIV who were also diagnosed with TB at the time of data extraction were considered co-infected. This definition does not take into account the patient's previous TB/HIV status; it is just a snapshot at the time of data extraction.
2) *Lost to follow-up*: we considered lost to follow-up any patient who had not attended the treatment site for at least 3 months (90 days) after the date of the last clinical visit, and for whom no health status information was known before the date of data extraction. This definition was chosen to align with national guidelines for follow-up of patients on ART in Guinea. Patients lost to follow-up had the event on the date of the last clinical visit.
3) *Deceased patient*: Deceased patients had the event of interest on the date of death, or, if not available, on the date of last visit to the site.
4) *Transferred Patient*: Any patient referred to another service providing ART before the date of data extraction was considered transferred. These patients were censored on the date of transfer.

2.6. Data Analysis

The data contained in the various electronic patient tracking databases were exported to Excel for cleaning and processing. The processed data were exported into IBM SPSS Statistics 25 software for analysis.

2.6.1. Descriptive Analysis

Quantitative variables were summarized using the mean ± standard deviation. Quantitative variables whose distribution does not follow a normal distribution were described by the median and its interquartile range. Proportions with their 95% confidence intervals were estimated to describe qualitative or categorical variables. We used Kaplan Meir survival analysis techniques to estimate the cumulative incidence of death among patients on antiretroviral therapy at different follow-up periods.

2.6.2. Univariate and Multivariate Analysis

In this study, we constructed an outcome model considering TB-HIV co-infection to identify factors associated with the occurrence of TB in HIV-infected patients (here, HIV is considered the entry point into the care delivery system). We therefore coded "1" for HIV patients not infected with TB "0" for others.

The Chi-square test was used for bivariate analysis to assess the association between the independent variables and the outcome variable (TB/HIV co-infection Yes/No). We used multivariate logistic regression to identify associations significantly associated with the occurrence of TB in patients living with HIV. Covariates for logistic regression were selected if the p value was less than or equal to 0.20 in bivariate. Multicollinearity between covariates was examined using variance inflation factors. We adjusted simultaneously for multiple variables in the models. The associations observed in this study were not due to confounding by any of the other variables in the model.

3. Results

3.1. Characteristics of the Participants

In this study we included 14,373 HIV-infected patients who initiated antiretroviral therapy between April 2015 and March 2020 in nine (9) large cohort sites in Guinea. A gender breakdown shows that of these patients, 4542 (31.6%) were male and 9831 (68.4%) were female. The married and unemployed represented 75.66% and 61.73% respectively. Their median age was 35 (29 - 45) years. Patients who initiated antiretroviral therapy at an advanced stage of HIV infection represented 43.87% of the sample, 24.15% at stage III and 19.72% at stage IV. Median Cd4 counts and viral load were 242 (145 - 427) cells/mm3 and 36,891 (2,263 - 198,266) copies/mm3, respectively (table 1).

Table 1. *Frequency of Tuberculosis by socio-demographic, clinical and laboratory characteristics of HIV-infected patients managed at nine large cohort sites, Guinea, April 2015 - March 2020.*

Characteristics	Total (%)	TB/HIV co-infection		p-value
		No n (%)	Yes n (%)	
Total patients	14,373	11,325 (78.81)	3,045 (21.19)	
Legal status of the site				*< 0.001*
Public	11750 (81.75)	9011 (76.69)	2739 (23.31)	
Private	2623 (18.25)	2317 (88.33)	306 (11.67)	
age (N = 14373)(IQR)	35 (29 - 45)			
Age range				*0.001*
Under 15 _	143 (0.99)	118 (82.52)	25 (17.48)	
15 - 24 years old	1580 (10.99)	1278 (80.89)	302 (19.11)	
25 - 34 years old	5064 (35.23)	4057 (80.11)	1007 (19.89)	
35 - 44 years old	3988 (27.75)	3110 (77.98)	878 (22.02)	
45 - 54 years old	2272 (15.81)	1760 (77.50)	512 (22.50)	
55 and over	1326 (9.23)	1005 (75.80)	321 (24.20)	
Patient gender				*< 0.001*
Man	4542 (31.6)	3477 (76.55)	1065 (23.45)	
Women	9831 (68.4)	7851 (79.86)	1980 (20.14)	
Patient marital status				*0.886*
Not - married	3498 (24.34)	2754 (78.73)	744 (21.27)	
Married / free union	10872 (75.66)	8572 (78.84)	2300 (21.16)	
Missing	3			
Profession/occupation				*0.634*
Unemployed _	8870 (61.73)	7002 (78.94)	1868 (21.06)	
Employee	5497 (38.27)	4321 (78.61)	1176 (21.39)	
Missing	6			
Type of HIV				*0.952*
HIV Type I	14263 (99.32)	11242 (78.82)	3021 (21.18)	
Other Types (II or I and II)	98 (0.68)	77 (78.57)	21 (21.43)	
Missing	12			
WHO clinical stage of HIV infection				*< 0.001*
Stage IV	2834 (19.72)	1962 (69.23)	872 (30.77)	
Stage III	3471 (24.15)	2194 (63.21)	1277 (36.79)	
Stage II	3569 (24.83)	3076 (86.19)	493 (13.81)	
Stage I	4499 (31.30)	4096 (91.04)	403 (8.96)	
Median CD4 (N = 14373)(IQR)	242 (145 - 427)			
Range of CD4 count in cells/mm3				*< 0.001*
< 100	2423 (16.90)	1931 (76.69)	492 (20.31)	
100 - 200	2372 (16.54)	1539 (64.88)	833 (35.12)	
200 - 350	4140 (28.87)	2799 (67.61)	1341 (32.39)	
> 350	5405 (28.69)	5027 (93.01)	378 (6.99)	
Missing	33			
Median viral load (N = 11,214) (IQR)	36,891 (2,263 - 19,8266)			
Viral load Range copies/mm ^{3}				*< 0.001*
≥100,000	3924 (34.97)	2604 (66.36)	1320 (33.64)	
10,000 - 100,000	3768 (33.58)	2723 (72.27)	1045 (27.73)	
1,000 - 10,000	1816 (16.18)	1625 (89.48)	191 (10.52)	
≤ 1000	1714 (15.27)	1591 (92.82)	123 (7.18)	
Missing	3151			
ART regimen				*0.007*
TDF + 3TC + EFV	12733 (88.60)	9998 (78.52)	2735 (21.48)	
AZT + 3TC + NVP	589 (4.10)	494 (83.87)	95 (16.13)	
Other ARV regimens	1051 (7.30)	836 (79.54)	215 (20.46)	

3.2. Prevalence of Tuberculosis Among People Living with HIV

The prevalence of tuberculosis among HIV-infected patients was 21.19% (3045/14 373). The distribution of TB prevalence was not different according to marital status, patient's profession or occupation and HIV type. However, differences were observed between HIV and TB co-infected patients and other patients living with HIV for the following variables (p-value ≤ 0.05): site legal status, patient age, patient gender, clinical stage of HIV infection, viral load, and Cd4 count at ART initiation (table 1).

3.3. Final Follow-Up Status of Participants at the End of the Study

At the end of the study period, 6.80% of patients had died, 26.80% were considered lost to follow-up, 8.20% were transferred to another site to continue follow-up, and 58.20%

were still being followed up at the initial sites (figure 1), for an overall retention rate of 66.4% for a median follow-up time of 2.08 years.

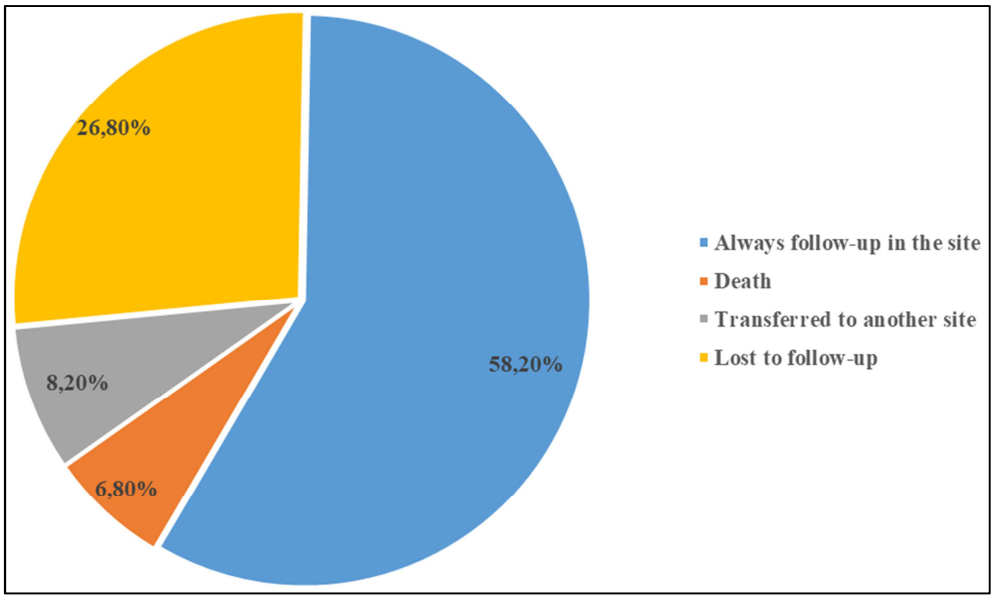

Figure 1. *Final follow-up status as of October 31, 2020 of 14,373 HIV-infected patients who initiated antiretroviral therapy at nine large cohort sites, Guinea, April 2015 - March 2020.*

Mortality among patients living VIH and co-infected TB/HIV patients

At the end of the study, the cumulative probability of death for patients on ART was 6.80%, or an incidence rate of 3.27 per 100 person-years. This cumulative probability of death increased with the time of follow-up of the patients. Thus, it increased from 2.56% at six (6) months of follow-up to 6.81% at 2 years of follow-up and then to 19.59% at 5 years of follow-up. The cumulative probability of death is higher in HIV/TB co-infected patients than in others. Thus, it increased from 2.29% at 6 months' follow-up to 18.86% at 5 years' follow-up in no co-infected patients; however, it increased from 3.63% at 6 months' follow-up to 22.37% at 5 years' follow-up in HIV/TB co-infected patients (Table 2). Figure 2 shows that the Kaplan Meier risk of death curves of co-infected patients are higher than those of no co-infected patients. This observed difference between the curves is statistically significant (Log Rank Test > 0.005).

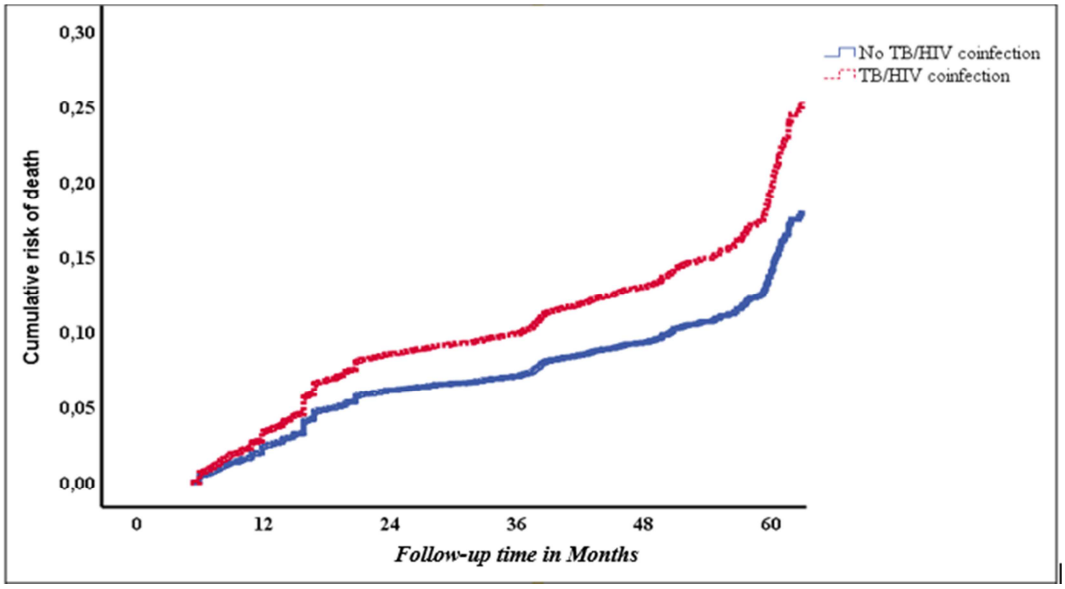

Figure 2. *Kaplan-Meier curve of cumulative probability of death during follow-up to October 31, 2020 of 14,373 HIV-infected patients who initiated antiretroviral therapy at nine large-cohort sites, Guinea, April 2015 - March 2020 (Log Rank Test > 0.001).*

Table 2. *Mortality table as of October 31, 2020 of 14,373 HIV-infected patients who initiated antiretroviral therapy at nine large cohort sites, Guinea, April 2015 - March 2020.*

Follow-up time in Months	Whole			Not TB/HIV co-infected			TB/HIV co-infected		
	Patients at risk	Cumulative probability of death (%)	95% CI	Patients at risk		95% CI	Patients at risk	Cumulative probability of death (%)	95% CI
0	14223	0.51	0.45 – 0.57	11236	0.44	0.37 - 0.50	2987	0.80	0.64 -0.97
6	12808	2.56	2.43 – 2.70	10173	2.29	2.14 – 2.43	2635	3.63	3.27 – 3.99
12	10295	5.08	4.88 – 5.28	8239	4.49	4.28 – 4.71	2057	7.38	6.84 – 7.91
18	8294	6.33	6.10 – 6.56	6678	5.71	5.46 – 5.96	1616	8.75	8.15 – 9.35
24	6866	6.81	6.56 – 7.05	5502	6.15	5.89 – 6.42	1365	9.35	8.73 – 9.98
30	5675	7.28	7.02 – 7.54	4524	6.53	6.25 – 6.80	1151	10.22	9.55 – 10.89
36	4510	8.72	8.41 – 9.03	3582	8.12	7.78 – 8.46	929	11.09	10.37 – 11.82
42	3301	9.55	9.21 – 9.89	2578	8.90	8.53 – 9.28	723	12.07	11.28 – 12.87
48	2273	10.90	10.50 – 11.31	1760	10.40	9.94 – 10.86	514	12.93	12.05 – 13.81
54	1328	13.72	13.14 – 14.30	1031	13.53	12.86 – 14.21	297	14.69	13.58 – 15.80
60	441	19.59	18.42 – 20.76	341	18.86	17.57 – 20.15	100	22.37	19.72 – 25.01

Associated factors of the occurrence of tuberculosis among patients living with HIV

Table 3 presents the results that advanced clinical stage of HIV infection at ART initiation, low CD4 count at ART initiation, and high viral load at ART initiation were statistically associated with the occurrence of TB in HIV-infected patients (all AOR > 1, p-value < 0.05). However, there were no statistically significant differences between HIV/TB co-infected patients and other patients living with HIV with respect to age, patient gender, marital status, legal status of care site, occupation/occupation, HIV type, and ARV regimen (all p-value > 0.05).

Table 3. *Multivariate regression analysis of factors associated with the occurrence of TB in ART-initiated HIV-infected patients managed at nine large-cohort sites, Guinea, April 2015-March 2020.*

Characteristics	AOR	(95% CI)	p-value
Patient gender			
Man	1,046	(0.945 – 1.159)	0.382
Women	1		
Age range			
Under 15	1		
15 - 24 years old	0.916	(0.554 – 1.514)	0.732
25 - 34 years old	0.813	(0.660 – 1.003)	0.053
35 - 44 years old	0.863	(0.730 – 1.022)	0.088
45 - 54 years old	0.958	(0.807 – 1.136)	0.621
55 and over	0.921	(0.764 – 1.109)	0.384
WHO clinical stage of HIV infection			
Advanced stage (III & IV)	1,681	(1.489 – 1.898)	< 0.001
Early Stage (I & II)	1		
CD4 count range (cells/mm3)			
< 100	1,793	(2.497 – 2.147)	< 0.001
100 - 200	2,676	(2.237 – 3.202)	< 0.001
200 - 350	2,449	(2.088 – 2.872)	< 0.001
> 350	1		
Viral load range (copies/mm3)			
≥100,000	2,135	(1.710 – 2.667)	< 0.001
10,000 - 100,000	1,735	(1.389 – 2.166)	< 0.001
1,000 - 10,000	1,213	(0.951 – 1.546)	0.120
≤ 1000	1		

4. Discussion

The objective of this study was to estimate the prevalence of tuberculosis and to identify factors associated with its occurrence among HIV-infected patients on antiretroviral therapy. It also estimated the survival rate among HIV patients co-infected with TB and among HIV patients not co-infected with TB. It was conducted in 9 large cohort sites, eight of which are located in Conakry (Communal Medical Center of Coleah, Communal Medical Center of Matam, Communal Medical Center of Flamboyant, Communal Medical Center of Miniere, Health Center of Dabompa, Health Center of Gbessia Port 1, Health Center of Wanindara, Health Center of Tombolia), and one of which is located in the interior of the country (Regional Specialized Hospital Center of Macenta).

Overall, the prevalence of TB among HIV-infected patients was 21.19%. This result is similar to that of a study conducted in Togo which found a prevalence of 23.7% [21]. This large proportion of co-infection revealed by our study could be explained by three things. Firstly, no observance

with antiretroviral treatment which would lead to therapeutic failure which, in turn, would be the gateway to opportunistic infections, with tuberculosis as the first line of infection. Secondly, by the low realization of preventive treatment of tuberculosis with isoniazid in HIV patients not infected with tuberculosis; this is due to the low availability of isoniazid in several HIV care centers in Guinea. Third, the high prevalence of TB among HIV patients is explained by their late initiation of antiretroviral therapy (initiation of antiretroviral therapy at an advanced stage of HIV infection, which is often associated with opportunistic infections, including TB). It should be noted, however, that the result of our study is lower than that of two other studies conducted in Ethiopia which found prevalence's of 27.7% and 37.4% respectively [4, 22]. This difference between countries could be explained by the difference in study settings, the type of HIV epidemic in the country, the organization of health care provision for people living with HIV, the sample size and duration of the study, or the study area.

At the end of this study, 6.80% of the participants had died. Our result is similar to that of a study conducted in Sikasso, Mali, which found 5% deaths [23]. This result of our study could be explained in part by the low reporting of deaths among HIV patients by the sites; this is due to the weakness of the systems for managing the quality of HIV patient follow-up data for events that occur at the community level. This can also be explained by the effectiveness of triple antiretroviral therapy in reducing mortality and morbidity among people living with HIV.

At the end of this study, the number of people lost to follow-up was 26.80% of the participants, a result that is much higher than the one found in Mali, which was estimated at 6% [23]. This large proportion of lost to follow-up in our study could be explained by unreported displacement of patients to other sites, a problem of counseling on the benefits of ART, poor behavior of health workers towards patients, a problem of transportation to the site of care, especially in rural areas, and also unreported deaths. It should also be noted that failure to investigate lost to follow-up cases could lead to an overestimation of lost to follow-up cases, due to the following situations: ignorance of deaths among lost to follow-up cases and failure to take into account patients who were self-transferred to another site without the original site being informed. This situation could be controlled by putting in place a good electronic tracking mechanism of all patients living with HIV followed up in the different sites of the country.

Also at the end of the study, it was noted that 8.20% of patients were formally transferred to another site to continue follow-up and 58.20% of patients were still being followed up at the initial sites. A study conducted in Mali in 2018 reported a formal transfer rate of 5% and continued follow-up at the initial sites at 74% [23]. The low transfer rate reported in this study could be explained by self-transfers not reported or reported by the initial sites.

We also noted in this study that the cumulative probability of death was higher in HIV/TB co-infected patients than in non-co-infected patients. It increased from 2.29% at 6 months' follow-up to 18.86% at 5 years' follow-up in no co-infected patients. However, it increased from 3.63% at 6 months of follow-up to 22.37% at 5 years of follow-up in HIV and TB co-infected patients. This result corroborates with that of a study conducted in Benin in 2017, which found that mortality related to TB/HIV coinfection was 25% compared with 17% in HIV patients not infected with TB. This result also corroborates with those of another study conducted in Morocco in 2019 which found that the mortality rate of co-infected subjects was 8.80% and it was 2.20% in non-co-infected patients [24, 25]. This result of our study supports the claims that tuberculosis is one of the leading causes of death in HIV-infected patients [3], hence the need to strengthen community-based interventions aimed at the early diagnosis of HIV infection.

It was found in our study that advanced clinical stage of HIV infection at the time of ART initiation, low CD4 count at ART initiation and high viral load at ART initiation were the factors statistically associated with the occurrence of TB in HIV-infected patients. This result is similar to those of other studies conducted in Ethiopia and Tanzania [4, 14, 15]. This could be explained by the associated strong immunosuppression leaving the field fertile for opportunistic infections. On the other hand, other studies conducted in Brazil and Ghana found that black race, low weight: < 50 Kg, male sex, low body mass index: BMI < 18.5 kg/m2 were also associated with the occurrence of tuberculosis in patients living with HIV [1, 4, 9, 10].

This study covered a long follow-up period for HIV-infected patients (5 years) and included a large sample of patients on treatment (more than 14,000 patients). It took into account sites in Conakry and those in the interior, although the number of the latter remains low. The results of this study could be considered representative of the country's sites.

Despite the strengths mentioned above, this study has some limitations. The data analyzed were collected retrospectively from longitudinal patient follow-up databases, which presents a risk of information bias due to under-reporting of some events of interest (i.e., deaths and transfers) and some key variables such as Cd4 and viral load.

5. Conclusion

In this study, the prevalence of TB/HIV co-infection was 21.19%. At the end of the study period, 6.80% of these patients had died, 26.80% were considered lost to follow-up, 8.20% were transferred to another site for further follow-up, and 58.20% were still being followed at the original sites. This study showed that the cumulative probability of death was higher in patients co-infected with HIV and TB than in those who were not.

Advanced clinical stage of HIV infection at the start of antiretroviral therapy, low CD4 count at the start of antiretroviral therapy, and high viral load at the start of antiretroviral therapy were statistically associated with the development of TB in HIV-infected patients. A mixed study

(a prospective quantitative component and a qualitative component) could provide a better understanding of the occurrence of TB in HIV-infected patients in Guinea.

List of Abbreviations

BMI: Body Mass Index
HIV: Human Immunodefiency
WHO: World Health Organization
CD4: Cluster of Differentiation
IQR: Interquartile Range
ART: Antiretroviral Therapy
AIDS: Acquired Immunodeficiency Syndrome
PLHIV: People Living with HIV
AOR: Adjusted Odd Ratio
TB: Tuberculosis

Declarations

Ethical Approval and Consent to Participate

For data collection, authorization from the national HIV/AIDS and hepatitis program was obtained through a letter of approval. This is simply a programmatic performance evaluation study of the Guinean national AIDS and hepatitis program. It was conducted by a PhD candidate. Verbal consent was obtained from site officials prior to data collection. Informed consent was obtained from the patients lost to follow-up before the interview. Arrangements were made to ensure confidentiality of information regarding the identity of patients included in our study.

Availability of Data and Materials

The data used in the study are not publicly available. Anyone wishing to obtain these data for scientific purposes may request them from the authors of this work.

Competing Interests

The authors stated that there is no competing interest.

Consent for Publication

Not applicable.

Authors' Contributions

Niouma Nestor Leno, Study Design, data analysis and manuscript drafting; Foromo Guilavogui, Study Design, data analysis and manuscript drafting, Mohamed Diallo, manuscript drafting; Aboubacar Sidiki Magassouba, Manuscript reviewing; Youssouf KOITA, Manuscript reviewing; Laye Kaba, Manuscript reviewing; Souleymane CHALOUB, Data collection and manuscript reviewing, Andre KAMANO, Data collection and manuscript reviewing; Alexandre DELAMOU, Review of study design and validation of data analysis; Alioune CAMARA, Review of study design and validation of data analysis.

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