J AIDS HIV Treat. 2024;6(1):65-75.

Journal of AIDS and HIV Treatment | Research Article

Immunological and Virological Characteristics of People Living with Human Immunodeficiency Virus on Antiretroviral Therapy in Bobo-Dioulasso Hospital, Burkina Faso

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Received date: September 27, 2024, **Accepted date:** November 11, 2024

Citation: Dakouo SNP, Bazié WW, Sawadogo Y, Zoungrana J, Zougmoré A, Kaboré FN, et al. Immunological and Virological Characteristics of People Living with Human Immunodeficiency Virus on Antiretroviral Therapy in Bobo-Dioulasso Hospital, Burkina Faso. J AIDS HIV Treat. 2024;6(1):65-75.

Abstract

Background: Human immunodeficiency virus infection remains a public health challenge, mostly in sub-Saharan Africa. This region accounts for 65% of those infected and contributes to 50% of new infections. The World Health Organization advocates for early antiretroviral therapy (ART) initiation for all newly diagnosed individuals. If monitoring viral load (VL) after ART initiation is increasingly common, baseline VL testing is under-utilized in resource-limited settings. However, it is known that the baseline HIV viral load significantly influences the likelihood of achieving virological suppression in individuals starting antiretroviral therapy. The aim of this study was to investigate the immunological and virological profile of people living with HIV (PLWHIV) and associated factors at the initiation of ART.

Methods: We performed a retrospective analysis of data from an open cohort of PLWHIV followed at the Souro SANOU University Hospital adult day hospital who initiated antiretroviral therapy between January 2011 to October 2017. The analysis included patients who had a baseline HIV-1 viral load before ART initiation.

Results: There were 295 PLWHIV included, 67.1% of whom were female, and the median age was 39 years. The median viral load was 252,385 (IQR: 56,023-847,910) copies/mL and the median CD4 T cell count was 177 cells/µL (IQR:70–296). PLWHIV with baseline HIV-1 RNA >100,000 copies/mL and CD4+ count <200 cells/µL were respectively 66.8% and 57.9%. In logistic regression multivariate analysis, WHO clinical stage 3 (Adjusted Odds Ratio (AOR): 2.3 (95%CI 1.25–4.35)), stage 4 (AOR: 4.5 (95%CI 1.45–13.87)), viral load between 100,000–1,000,000 (AOR: 4.2 (95%CI 1.66–10.66)), and above 1,000,000 (AOR: 5.3 (95%CI 1.90–14.76)) were associated with immunosuppression. Regarding viremia, clinical suspicion as a circumstance for HIV diagnosis (AOR: 2.4 (95%CI 1.16–5.19)), WHO clinical stage 4 (AOR: 3.3 (95%CI 1.11–9.61)) were associated with a viremia above 1,000,000 copies/mL.

Conclusions: Regular monitoring of follow-up data would enable us to understand the factors associated with late presentation to HIV/AIDS services and to design effective treatment programs and strategies to meet UNAIDS targets.

Keywords: HIV, Immunological, Virological, Late presentation, Burkina Faso

Introduction

Human Immunodeficiency Virus (HIV) infection remains a public health challenge, mostly in sub-Saharan African countries. The global estimates of HIV for adults and children in 2023 reported 39.9 million people living with HIV (PLWH) with 1.3 million new HIV infections [1]. To control the pandemic, the World Health Organization (WHO) has implemented strategies with a triple target called "95:95:95" since 2014. The global target aims to ensure that by 2025, 95% of people living with HIV (PLWHIV) know their HIV status, 95% of people who know their status are receiving treatment and 95% of people with HIV treatment have a suppressed viral load so their immune system remains strong, and the likelihood of their infection being passed on is greatly reduced [2]. Antiretroviral therapy (ART) is recognized as the most effective method to prevent new HIV infections and reduce AIDS-related mortality [3-5]. The World Health Organization advocates for early ART initiation for all newly diagnosed individuals. The effects of early treatment in terms of better restoration of immune competence, reduction of morbidity and mortality, decrease in the viral reservoir size, and reduction in transmission of the virus to sexual partners have been described [5-7]. Then, the WHO criteria of CD4 count, viral load level, or clinical stage for treatment initiation were dropped [8]. To achieve the second objective, the "treat all" approach has been recommended since 2016 by the WHO guidelines [9].

In Burkina Faso, HIV remains a major health concern with 95,000 PLWHIV and 1,900 Adults and children newly infected with HIV in 2023. Country data on UNAIDS targets are 83% for the first 95, 77% for the second 95, and 71% for the third 95 [1]. If the test and treat strategy is implemented, the later screening and late linking to care do not allow the expected effects of the test and treatment in terms of individual health and prevention of virus transmission with the concept of treatment as prevention. If the focus is on achieving the third objective with an assessment of the viral load (VL) at six months and one year after starting the ART, the baseline VL testing and CD4 T-cell count are under-utilized in resource-limited settings due to costs and availability [10,11].

Research indicates that lower baseline CD4 counts are associated with poorer virological suppression and higher rates of virological failure, underscoring the importance of early intervention. Álvarez *et al.* reported that PLWHIV with baseline CD4 counts ≤ 200 cells/µL showed a markedly lower rate of virological suppression at 48 weeks, higher rates of viral blips, and low-level viremia. The risk of virological failure was significantly elevated (3.12 times higher) in this group [12]. Conversely, Fatti *et al.* showed that PLWHIV with baseline CD4 counts ≥ 500 cells/µL experienced excellent virological outcomes, with virological suppression rates exceeding 94% over 30 months [13]. The incidence of virological failure is substantially lower in this group, indicating a strong protective effect of higher baseline CD4 counts [13]. Concerning VL, studies reported that the baseline HIV VL significantly influences the likelihood of achieving virological suppression in individuals starting ART impacting both the rate and time to virological success [13-16]. The higher pre-therapy VLs are associated with lower rates of virological success. Individuals with baseline VLs ≥100,000 copies/mL have a markedly lower chance of achieving virological suppression compared to those with lower VLs [16]. For instance, only 74% of patients with VLs >1,000,000 copies/mL achieved suppression within the first year, compared to over 95% for those with VLs <100,000 copies/mL [15]. A cross-over study found that patients with pre-ART VLs >500,000 copies/mL had a significantly higher risk of virological rebound after initial suppression [14].

The systematic performance of this baseline check-up would make it possible to estimate the stage of the infection at the time of screening or ART initiation and to plan a personalized follow-up. Based on CD4 T cell count, these data could also be used to notify late presentation in care and alert policymakers to strengthen HIV testing awareness campaigns. Knowing that the baseline virologic and immunologic parameters significantly correlate with virological outcomes in individuals living with HIV who initiate ART [17,18], this study intends to describe the immunological and virological profile of PLWHIV and associated factors at the initiation of antiretroviral therapy in Souro Sanou University Hospital adult day hospital.

Methods

Study design and setting

A descriptive and analytical cross-sectional study was performed on data from an open cohort of PLWHIV followed up at the Souro Sanou University Hospital adult day hospital in Bobo-Dioulasso, Burkina Faso. The University Hospital is a reference place for the follow-up of PLWHIV [19,20]. This study reviewed data collected between January 2011 to October 2017.

Participants

Participants in the study were HIV-positive patients 17 years of age and older, who are being followed for the management of their HIV infection. The eligibility criteria for inclusion in the analysis were being newly initiated on treatment during the study period and having VL measurement prior to ART initiation.

Data sources/ measurement

In Routine follow-up, patients' socio-demographic, clinical, therapeutic, and biological monitoring data were recorded with Evaluation and Operational Monitoring of ESTHER Programs (EOMEP) software that was regularly filled in by the healthcare team during the follow-up appointments. The data collected were de-identified, and unique follow up identification numbers were used instead of patient's names, and patient's records were handled with strict confidentiality.

Antiretroviral therapy

Antiretroviral therapy was initiated and monitored according to national guidelines adapted from the WHO recommendations for each period. The first-line triple drug combination treatment included two nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs) and a non-nucleoside reverse transcriptase inhibitor (NNRTIs). The available NRTIs molecules (Zidovudine, Lamivudine, Stavudine, Abacavir, Tenofovir Dixoproxil Fumarate, and Emtricitabine) and NRTIs (Nevirapine and Efavirenz) were used for ART initiation.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of the Souro Sanou University Hospital adult day-hospital. Patient records/data were anonymized and de-identified prior to exporting and analysis using an encoding process (6-digit number without specifying the date of birth).

Data analysis

The Exported data were analyzed using the EPI Info 7 software. Standard statistical methods were used to describe the sociodemographic, clinic and biological characteristics. The quantitative variables were presented as median with interquartile range (IQR), and the qualitative variables as frequency and percentages (%). The Chi square test, if applicable or Fisher test was used for the comparison of proportions and the Mann Whitney test for quantitative variables comparison. The study used a logistic regression model to assess the associations of these characteristics with high viremia (VL ≥ 1,000,000 copies/mL) and immunodepression (CD4 T cell count < 200 cell/mL). All independent variables associated with high viremia and immunodepression at a significant level (p-value) of 20% in bivariate analysis have been included in the complete multivariate model. We used a backward elimination strategy withdrawing variables with the highest p-value to eventually retain in the final model, covariates with a p-value lower than 5%.

Results

Participants sociodemographic and clinical characteristics at ART initiation

Over all, 295 PLWHIV were initiated on antiretroviral therapy during the study period. The median age was 39 (IQR 33–45) years, 67.1% (198/295) were female, 63.7% (188/295) were living currently married/cohabitating, and 54.6% (161/295) had no education. The women were younger (p<0.0001), less educated (p<0.0001), and single (p=0.0058) **(Table 1)**. Out of the participants (295), 73.1% reported having a sexual partner, and 45.6% of those reported informing their partner of their HIV status. There was no significant difference between men and women in having a sexual partner (p= 0.7965) and informing them of their HIV status (p=0.3184). However, the sexual partner's HIV status was unknown by 68.6% of the participants who had a sexual partner and was positive for 21.6%. 65.8% knew their HIV status after clinical suspicion

Table 1. Participants clinical and sociodemographic characteristics at antiretroviral therapy initiation stratified by sex.

Characteristics	All participants n (%)	Male (n=97) n (%)	Female (n=198) n (%)	P
Age (years): median (IQR[a])	39 (33-45)	46 (44-51)	36 (31-39)	<0.0001
<24	17 (5.8)	1 (1.0))	16 (8.1)	
25-44	193 (65.4)	25 (25.8)	168 (84.8)	
≥ 45	85 (28.8)	71 (73.2)	14 (7.1)	
Diagnostic circumstance				
Clinical suspicion	194 (65.8)	90 (92.8)	104 (58.1)	<0.0001
Voluntary screening	82 (27.8)	7 (7.2)	75 (41.9)	
Pregnancy (PMCTH[b]))	19 (6.4)			
Marital status				
Currently married/cohabitating	188 (63.7)	66 (68.0)	122 (61.6)	0.0058
Never married	42 (14.2)	5 (5.2)	37 (18.7)	
Separated/Divorced/Widowed	65 (22.0)	26 (26.8)	39 (19.7)	

School				
Uneducated	161 (54.6)	7 (7.2)	154 (77.8)	< 0.0001
1-5 (Primary)	73 (24.7)	47 (48.5)	26 (13.1)	
7-13 (Secondary)	61 (20.7)	43 (44.3)	18 (9.1)	
WHO[c] clinical stage				
Stage 1	75 (25.4)	22 (22.7)	53 (26.8)	0.7905
Stage 2	68 (23.1)	21 (21.6)	47 (23.7)	
Stage 3	126 (42.7)	45 (46.4)	81 (40.9)	
Stage 4	26 (8.8)	9 (9.3)	17 (8.6)	
Having a sexual partner (n=279)				
Yes	204 (73.1)	62 (72.1)	142 (73.6)	0.7965
No	75 (26.9)	24 (27.9)	51 (26.4)	
Partner aware of HIV status				
Yes	93 (45.6)	25 (40.3)	68 (47.9)	0.3184
No	111 (54.4)	37 (59.7)	74 (52.1)	
Sexual partner HIV status				
Positive	44 (21.6)	14 (22.6)	30 (21.1)	0.9734
Negative	20 (9.8)	6 (9.7)	14 (9.9)	
Unknown	140 (68.6)	42 (67.7)	98 (69.0)	

[a] IQR: Interquartile Range; [b] PMCTH: Prevention of Mother-to-Child Transmission of HIV; [c] WHO: World Health Organization

and 6.4% during the prenatal checkup. Patients at stages 2 and 3 of the WHO clinical staging of HIV disease in adults, adolescents, and children were in the majority with 23.1% and 42.7% respectively **(Table 1)**. The combined therapy including Tenofovir/Emtricitabine/Efavirenz was the most widely used for treatment initiation in patients **(Table 2)**.

Participant's immune and virological characteristics at ART enrolment in care

Viremia was detected in all participants, and the median viral load was 252,385 (IQR 56,023–847,910) copies/mL. Only 8.8% had a suppressed viral load (less than 1,000 copies/mL) before

Table 2. Antiretroviral drugs used to initiate treatment stratified by sex.

Characteristics	All participants n (%)	Male (n=97) n (%)	Female (n=198) n (%)	P
NRTIs[a] 1				
Abacavir	5 (1.7)	1 (1.0)	4 (2.0)	0.6842
Tenofovir	251 (85.1)	85 (87.6)	166 (83.8)	
Zidovudine	39 (13.2)	11 (11.3)	28 (14.1)	
NRTIs 2				
Emtricitabine	245 (83.1)	83 (85.6)	162 (81.8)	0.4201
Lamivudine	50 (16.9)	14 (14.4)	36 (18.2)	
NNRTIs[b]				
Efavirenz	259 (88.7)	88 (91.7)	171 (87.2)	0.2622
Nevirapine	33 (11.3)	8 (8.3)	25 (12.8)	
Protease inhibitors				
Lopinavir	9 (3.1)	3 (3.1)	6 (3.0)	0.9766

[a]NRTIs: Nucleoside Reverse Transcriptase Inhibitors; [b] NNRTIs: Non-Nucleoside Reverse Transcriptase Inhibitors.

treatment and 22.37% had a viral load greater than 1,000,000 copies/mL. The viral load was significantly higher in men than in women (p= 0.0032**) (Table 3)**.

The median CD4 T cell count was 177 cells/µL (IQR: 70–296). Regarding the CD4 class range, 57.9% were in immunodepression with a CD4 T cell count less than 200 cells/µL and 39.7%. No difference was observed between men and women in terms of CD4 counts **(Table 3)**.

Factors associated with immunodepression and high viremia at ART initiation

In multivariate analysis, after adjustment for school level, WHO clinical stages 3 (Adjusted OR 150 (AOR) (95%CI) 2.3 (1.25–4.35)) and 4 (AOR (95%CI) 4.5 (1.45–13.87)), viral load between 100,000 – 1,000,000 (AOR (95%CI) 4.2 (1.66–10.66)) and above 1,000,000 (AOR (95%CI) 5.3 (1.90–14.76)) were significantly associated with immunosuppression **(Table 4)**.

Table 3. Participants virological and immunological characteristics at antiretroviral therapy initiation.

Characteristics	All participants n (%)	Male n (%)	Female n (%)	P-value
Initial Viral load (copies/mL)				
Median (IQR[a])	252,385 (56,023-847,910)	357,970 (92,220-1,150,000)	180,521 (42,155-685,968)	0.0032
<10,000	26 (8.8)	2 (2.1)	24 (12.1)	0.0165
10,000-100,000	72 (24.4)	23 (23.7)	49 (24.7)	
100,000-1,000,000	131 (44.4)	44 (45.4)	87 (43.9)	
≥ 1,000,000	66 (22.4)	28 (28.9)	38 (19.2)	
CD4 T cells count (cells/µL)				
Median (IQR)	177 (70-296)	158 (74-275)	186 (70-305)	0.3016
< 200	169 (57.9)	60 (61.9)	109 (55.1)	0.4324
200 - 349	76 (25.8)	25 (25.8)	51 (25.8)	
350-500	41 (13.9)	9 (9.3)	32 (16.2)	
> 500	9 (3.1)	3 (3.1)	6 (3.0)	

IQR: Interquartile Range

Table 4. Factors associated with immunodepression at antiretroviral therapy initiation.

Characteristics	CD4 <200 cells n (%)	Odds ratio (95%CI[b])	P	Adjusted OR[a] (95%CI)	P
Age (years)			0.6705		
< 24	11 (6.5)	1			
25-44	110 (65.1)	0.7 (0.26-2.03)			
≥ 45	48 (28.4)	0.7 (0.24-2.09)			
Sex			0.2675		
Female	109 (64.5)	1			
Male	60 (35.5)	1.3 (0.81-2.17)			
Diagnostic circumstance			0.8136		
Voluntary screening	43 (25.4)	1			
Clinical suspicion	118 (69.8)	1.4 (0.84-2.37)			
During pregnancy (TME)	8 (4.7)	0.7 (0.24-1.81)			
Marital status			0.7193		
Never married	23 (13.6)	1			

Currently married/cohabitating	108 (63.9)	1.1 (0.57-2.19)			
Separated/Divorced/Widowed	38 (22.5)	1.2 (0.53-2.54)			
School			0.0853		0.3189
Uneducated	98 (58.0)	1		1	
1-6 (Primary)	42 (24.8)	0.9 (0.50-1.53		0.8 (0.43-1.47)	0.4707
7-13 (Secondary)	29 (17.2)	0.6 (0.32-1.05)		0.7 (0.39-1.42)	0.3654
WHO clinical stage			<0.0001		0.0011
Stage 1	31 (18.3)	1		1	
Stage 2	35 (20.7)	1.5 (0.78-2.92)		1.6 (0.77-3.20)	0.2117
Stage 3	82 (48.5)	2.6 (1.45-4.76)		2.3 (1.25-4.35)	0.0075
Stage 4	21 (12.4)	5.9 (2.03-17.52)		4.5 (1.45-13.87)	0.0092
Viral load			< 0.0001		<0.0001
< 10,000	8 (4.7)	1		1	
10,000-100,000	24 (14.2)	1.1 (0.43-2.96		1.1 (0.41-2.92)	0.8749
100,000-1,000,000	88 (52.1)	4.6 (1.86-11.43)		4.2 (1.66-10.66)	0.0024
≥ 1,000,000	49 (29.0)	6.5 (2.38-17.61)		5.3 (1.90-14.76)	0.0014
[a]OR: Odds Ratio; [b]CI : Confidence Interval					

For high viremia, in multivariate analysis, after adjustment for sex, clinical suspicion as a circumstance for HIV testing (AOR (95%CI) 2.4 (1.16–5.19)), WHO clinical stage 4 (AOR (95%CI) 3.3 (1.11–9.61)), and a CD4 count between 200 and 500 (AOR (95%CI) 0.5 (0.24– 0.88)) were significantly associated with high viremia **(Table 5)**.

Discussion

Our study, which included 295 people who initiated ART in Souro Sanou University Hospital Center adult day hospital, shows that PLWHIV were mostly women, live in couples, and few have shared their HIV serology with their sexual partners.

Table 5. Factors associated with high viremia at antiretroviral therapy initiation.

Characteristics	**Viral load ≥ 1,000,000 n (%)**	**Odds Ratio (95%CI[b])**	**P**	**Adjusted OR[a] (95%CI)**	**P**
Age			0.1363		0.6978
< 24	1 (1.5)	1		1	
25-44	43 (65.2)	4.6 (0.59-35.58)		3.7 (0.47-29.69)	0.2101
≥ 45	22 (33.3)	5.6 (0.70-44.62)		3.1 (0.34-27.79)	0.3139
Sex			0.0626		0.1897
Female	38 (57.6)	1		1	
Male	28 (42.4)	1.7 (0.97-3.00)		1.5 (0.82-2.67)	0.1897
Diagnostic circumstance			0.0707		0.0491
Voluntary screening	10 (15.2)	1		1	
Clinical suspicion	53 (80.3)	2.7 (1.30-5.63		2.4 (1.16-5.19)	0.0191
Pregnancy (TME)	3 (4.6)	1.3 (0.33-5.47)		1.8 (0.42-7.450)	0.4344
Marital status			0.3679		
Never married	3 (4.5)	1			
Currently married/cohabitating	51 (77.3)	4.8 (1.43-16.33)			
Separated/Divorced/Widowed	12 (18.2)	2.9 (0.78-11.13)			

School			0.4447		
Uneducated	31 (47.0)	1			
1-6 (Primary)	22 (33.3)	1.8 (0.96-3.41)			
7-13 (Secondary)	13 (19.7)	1.1 (0.55-2.35)			
WHO clinical stage			0.0063		0.0262
Stage 1	10 (15.1)	1		1	
Stage 2	15 (22.7)	1.8 (0.76-4.43)		1.6 (0.64-3.89)	0.3268
Stage 3	30 (45.5)	2.0 (0.93-4.44)		1.6 (0.74-3.72)	0.2237
Stage 4	11 (16.7)	4.8 (1.71-13.27)		3.3 (1.11-9.61)	0.0314
CD4 T cells count			0.0027		0.0095
< 200	49 (74.2)	1		1	
200 - 500	16 (24.2)	0.4 (0.21-0.72)		0.5 (0.24-0.88)	0.0195
>500	1 (1.5)	0.3 (0.04-2.51)		0.3 (0.03-2.50)	0.2569
[a]OR: Odds Ratio; [b]CI: Confidence Interval					

Moreover, most of the patients were in an immunosuppressed state with high viremia at ART initiation. This study has certain limitations. The reason for the delay in linking to care or initiation of treatment may be that the day hospital is only a follow-up center for PLWHIV and not a testing center. Patients diagnosed at other screening centers are referred to this department for follow-up and management. Offering a package of screening and care could reduce the delay for some patients. Also, the retrospective design of the study could induce selection and/or information bias in terms of data completeness.

The female face of HIV infection is reported by several authors in sub-Saharan African countries [21-23] as observed in our study. Chas et al. [19] in their analysis of the Souro Sanou University Hospital day-hospital patients from 2002 to 2012 noted that 71.1% of the patients were females. In Nigeria, Umar et al. reported that 68% of PLHIV initiating ART were female [24]. A multi-center, health facility-based cohort of newly diagnosed PLHIV who initiated first-line ART in eastern Ethiopia showed that 70.6% of them were female [25]. Indeed, women account for more than half (65%) of all people with HIV and 65% of new HIV infections among adults (15 years and older) in sub-Saharan Africa [1]. Likewise, adolescent girls and young women are twice as likely to become infected with HIV as their male counterparts [22,26]. The well-known physiological vulnerability of women is exacerbated by other socio-cultural, economic, social, and systemic factors [27-29]. In addition, the prevention of mother-to-child transmission of HIV programs with testing during pregnancy also provides an opportunity to screen women. In our study, it contributed to 19% of linking to HIV care. However, if HIV prevalence may have the face of a woman, studies reported that the men's heightened risk of AIDS-related death [30-32].

Regarding sharing HIV status, more than half of our patients had not shared their HIV status with their sexual partners at ART initiation. There was no gender difference in sharing information about positive HIV status. Reported disclosure rates can be difficult to compare across studies when researchers use different categories of people to whom individuals disclose [33]. Studies on disclosure to partners reveal even greater variations, ranging from less than 25% in studies from Burkina Faso to over 90% in studies from Ethiopia [33-37]. In addition, disclosure rates are usually based on self-reports, which may not always be reliable. A study carried out in Kenya revealed that a significant percentage (27%) of men who said they had revealed their status to their partner were contradicted by their female partners who said they didn't know their partner's status [38]. In Burkina Faso, despite the provisions of the law requiring the sharing of positive HIV status with sexual partners, this is not observed. HIV disclosure is a critical component of HIV/AIDS prevention of new infection with potential benefits for both the individual by experiencing increased social support and society by reducing HIV transmission risk behaviors [39,40]. However, despite these potential positive outcomes, disclosure also carries important risks. When information is shared with unaccepting individuals, it renders PLWHIV vulnerable to stigmatized reactions such as isolation, criticism, social ostracism, physical harm, divorce, separation or violence from partners, and rejection by friends [33,34,38,41-44].

Concerning treatments, Tenofovir, Emtricitabine, and Efavirenz were the most used for triple therapy. This preponderance is explained by the availability of combining fixed doses of Emtricitabine (200 mg), Tenofovir Disoproxil Fumarate (TDF; 300 mg) with Efavirenz (600 mg) [45,46]. Current treatment guidelines recommend this triple combination for initial therapy because of its excellent potency, tolerability, and favorable safety profile [47]. It represents the first once-daily, one-tablet antiretroviral regimen that offers better adherence

and is superior in terms of virologic suppression, CD4 response, and adverse events than Zidovudine, Lamivudine, and Efavirenz [45-47].

Regarding immunovirology parameters, participants had both high viremia and low CD4 T cell counts with 57.9% being in an immunosuppressed stage (CD4 < 200 cells/µL). The International Cohort Consortium of Infectious Diseases data showed that among 4,310 adults aged >18 years who initiated ART from 2014 to 2020, 25.3% had CD4 count ≤ 200 cells [12]. In Ethiopia, Fiseha *et al.* [48] reported that 28.8% of HIV-infected adults who initiated ART between September 2008 and June 2019 had a CD4 count of ≤ 200 cells. In South Africa, amongst all patients with a baseline CD4 (n = 703 869), 50.3% had counts ≤ 200 cells/mm^3 and amongst those starting ART since 2017, 37.2% had a baseline count ≤ 200 cells/mm^3 [49]. The high proportion in our study could be explained by the fact that our study is a single center, whereas others have included many patients in different PLWH care centers.

Concerning VL, our study showed that 66.8% started ART with VL above 100,000 copies/mL. This proportion remains higher than in most studies [25,50,51] and could be explained by delays in screening and linkage to care. Most of our patients were screened during the symptomatic phase of the infection and therefore had higher viremia. Higher pre-therapy VL and baseline CD4 counts ≤ 200 cells/µL were associated with lower rates of virological success [12-14,16] indicating that patients with these baseline immunological and virological characteristics may require more intensive management strategies. These data highlight the need to perform an initial biological check-up for personalized follow-up.

Viremia appeared to be higher in males compared to females. Sex differences have been described for diverse aspects of HIV-1 infection and disease progression [52-54]. The biological and genetic factors lead to these differential disease courses and outcomes in men and women. Farzadegan *et al.* reported that HIV-1 VL in untreated women was up to 40% lower than that in males [53]. These sex-based differences were described to be in part linked to innate immunity, in which the differential ability of plasmacytoid dendritic cells to produce interferon α following stimulation of Toll-like receptor 7 and upregulation of interferon-stimulated genes play a central role [52,54-56].

Overall, the high viremia and low CD4 count reflect the advanced stage of the infection and easily corroborate the clinical suspicion as a mode of diagnosis and the preponderance of WHO clinical stages 3 and 4. Indeed, most of our patients were screened based on clinical suspicion meaning a symptomatic phase of the infection. This form of screening is associated with a late diagnosis of HIV infection and late presentation to care. In Mozambique, Chone *et al.* reported that the male gender (AOR = 2.41), clinical suspicious test (AOR = 4.03), initiated by the health professional (AOR = 2.1,9), and fear of stigma (AOR = 2.80) were the main risk factors for late presentation to HIV care [57]. In African countries, the prevalence of late presentation for HIV care is high and varies according to the country. It was estimated to be 59.2% in Uganda [58], 60% in South Africa [59], 75.4% in Tanzania [60], 85.6% in Nigeria [61], and 89.7% in Cameroon [62].

With regards to the factors associated with initiating treatment at the stage of immunosuppression is higher viremia and no socio-demographic characteristics were associated. Mukolo *et al.* reported that male and particularly male heterosexuals, advanced age, and low socioeconomic status are predictors of late presentation to HIV care [63]. The rationale for the case of heterosexual men is that most targeted (aggressive) HIV prevention and testing interventions do not specifically target heterosexual males, making the latter most likely to have fewer opportunities for early HIV diagnosis than men who have sex with men, female sex workers, and women attending antenatal care, who have better access to provider-initiated testing [63]. Considering this discrimination towards heterosexual men would improve their rapid access to HIV testing and care.

Conclusion

This analysis showed that most people who started the antiretroviral therapy at the Souro Sanou University Hospital adult day hospital during the study period were in late presentation or at an advanced stage of HIV infection with high pretherapy VL and low CD4 T cell count. Implementing treatment recommendations for all coupled with screening strategies that target everyone and index testing, would allow individuals and public health to achieve the benefits of early treatment. Regular monitoring of follow-up data would enable us to understand the factors associated with late presentation to HIV/AIDS services and to design effective treatment programs and strategies to meet UNAIDS targets.

Competing Interests

The authors declare no competing interests.

Authors' Contributions

SNPD, WWB, and ASO conceived the study; SNPD collected data; WWB and SNPD analyzed data; WWB drafted the manuscript; YS, AZ, JZ, FNK, KMD, AP, and ASO participated in critical revision of the manuscript drafts. All authors approved the final version of the manuscript.

Acknowledgements

We acknowledge the Ministry of Health and the National Program for AIDS. We thank the organizations of people living with HIV/AIDS.

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