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ORIGINAL RESEARCH

Adherence to Antiretroviral Treatment Among People Who Started Treatment on the Same-Day of HIV Diagnosis in Ethiopia: A Multicenter Observational Study

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Introduction: Since the launch of universal "test and treat" approach in 2016, there has been a significant increase in persons initiated on antiretroviral therapy (ART) on the same-day of human immunodeficiency virus (HIV) diagnosis in low-income settings. However, there are limited studies that investigated the effect of rapid treatment initiation on adherence. In this study, we compared adherence to ART in people who started ART on the same-day of HIV diagnosis and those started more than 7 days after HIV diagnosis.

Methods: We conducted a retrospective cohort analysis using routinely collected data from multiple ART clinics. Participants were at least 15 years old, were newly diagnosed and started on ART between October 2016 and July 2018 in the Amhara region of Ethiopia. We used doubly-robust multivariable logistic regression model to estimate the adjusted effects on adherence.

Results: A total of 415 individuals who started ART on the same-day of HIV diagnosis and 527 individuals who started 7 days after their HIV diagnosis were included in the analysis. The proportion of participants who reported optimal adherence was significantly lower in the same-day group at 6- and 12-months (absolute risk difference of 6.5%; 95% CI: 1.1%, 11.9% and 6.8%; 95% CI: 1.2%, 12.5%, respectively) compared to the >7 days group. After adjusting for baseline and non-baseline covariates, the same-day group was less likely to have optimal adherence both at 6- and 12-months (adjusted RR=0.90; 95% CI: 0.86, 0.94 and RR=0.89; 95% CI: 0.83, 0.95, respectively) compared to the >7 days group.

Conclusion: We observed lower optimal adherence among individuals who started ART on the same-day of HIV diagnosis compared to those who started ART >7 days after their HIV diagnosis. Our findings highlight the importance of identifying adherence barriers, providing support, and ensuring treatment readiness before initiating individuals on same-day ART.

Keywords: same-day antiretroviral therapy, rapid ART, adherence, test and treat, Africa, Ethiopia

Introduction

There has been a tremendous achievement in the fight against human immunodeficiency virus (HIV) followed by a rapid scale-up of free antiretroviral treatment (ART). The increased access to ART has averted an estimated 12.1 million AIDS-related deaths since 2010.[1] However, worldwide, suboptimal ART adherence (<95% adherence level) has been one of the challenges of achieving optimal results from ART. Treatment adherence is a backbone for the success of ART program –

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that aims to reduce HIV-related morbidity and mortality and new HIV transmission through viral suppression. Durable viral suppression allows for maximal reconstitution of immune function and minimizes the emergence of drug-resistant virus.[2] It also reduces the risk of sexual HIV transmission between heterosexual serodiscordant couples.[3] However, without good or optimal treatment adherence (≥95% adherence), it is impossible to realize these benefits of ART.

A metanalysis that synthesized several studies across >26 countries before universal "test and treat" strategy showed a mean rate of 63.4% optimal adherence.[4] Another systematic review of ART adherence in sub-Saharan Africa reported average adherence score of 72.9%.[5] In Ethiopia, based on recent observational studies that assessed self-reported adherence using clinician's-record, optimal adherence ranged between 60.3% and 94.8% and varied by region.[6–8] On the other hand, a meta-analysis of studies conducted in sub-Saharan Africa identified that use of alcohol, male gender, use of traditional/herbal medicine, dissatisfaction with healthcare facility and healthcare workers, depression, discrimination and stigmatization, and poor social support as factors associated with non-adherence.[5] A study conducted in other setting also showed that gender and marital status have significant association with ART adherence.[9]

Different methods have been used to measure adherence. Clinician recorded self-reported adherence is the most common method and a standard of care adherence measurement tool in low resource settings due to its relative ease of use of documenting self-reported adherence to ART by a clinician during routine patient follow-up. Earlier on, self-report was believed to overestimate adherence level due to response bias.[10,11] However, studies from various settings have demonstrated that measures of adherence using self-report had no evidence of greater overestimation[12] or was highly correlated with viral suppression.[4,11,13,14]

Unlike previous extensive research, limited studies have investigated ART adherence post-universal "test and treat" policy implementation. A recent cross-sectional study that estimated the proportion of optimal adherence among PLHIV enrolled during universal "test and treat" approach in Ethiopia reported 49.3% and 95.9% optimal adherence measured by self-report using Morisky scale and seven-day recall, respectively.[15] In Nigeria,[16] a cohort study that evaluated the national scale-up of "test and treat" reported <70% good adherence among PLHIV who started ART within two weeks of HIV diagnosis, according to their pharmacy refill. However, despite the increasing trend in the proportions of PLHIV enrolling for ART on the same-day of diagnosis,[17–19] evidence of ART adherence among same-day ART initiators is lacking in low resource settings. In our observational study, we aimed to compare the proportion of optimal adherence between PLHIV who were initiated on ART on the same-day of HIV diagnosis and those initiated >7 days after HIV diagnosis.

Methods

Study Design

We conducted a retrospective cohort analysis using routinely collected data from multiple ART clinics to compare ART adherence among PLHIV who were initiated on same-day ART with those initiated >7 days after HIV diagnosis.

Study Setting and Participants

This study was part of the study that evaluates the effectiveness of same-day ART initiation. The detail of the study setting and participants has been published elsewhere.[20] Briefly, the study was conducted at 11 public health facilities in Bahir Dar and Gondar, two towns in the Amhara region of northwest Ethiopia. The study included PLHIV who were ≥15 years old and started ART on the same-day of HIV diagnosis or >7 days after the initial diagnosis between 20 October 2016 and 18 July 2018. We excluded medical records of individuals who were initiated on ART 1–7 days after diagnosis, aged <15 years old, pregnant, dead, transferred-in from another health facility, and transferred-out to another health facility within 12-months of ART initiation. In addition, we excluded medical records of patients whose rapid ART initiation was delayed due to management of tuberculosis or cryptococcal meningitis[21] and those who had died, due to missing adherence assessment.

Variables and Measurement

We defined optimal ART adherence (≥95% adherence) at 6- and 12-months following ART initiation as having clinician-recorded "good" adherence level at every visit in the previous 6-months of ART follow-up. Clinicians' assessment of adherence is based on patients' response about the number of missed antiretroviral (ARV) drug pills during the past month. The national guideline

recommends clinicians to label ART adherence as "good" if the person missed ≤2 doses (≥95% adherence), "fair" if the person missed 3–5 doses (85–94% adherence), and "poor" if the person missed ≥6 doses (<85% adherence) out of the 30 doses to be taken during each month of ART follow-up.[21]

Individuals with at least one "poor" or "fair" adherence measures in any of the last 6 months[22] or those who missed their ART refill follow-up for a period of ≥30 days (labeled as loss to follow-up (LTFU)) between any of the last 6 months[13] were categorized as having sub-optimal adherence.

We included both baseline and follow-up independent factors (biological, sociodemographic and clinical factors) in the analysis. We described the details of these factors including their measurements elsewhere.[20]

Study Size and Sampling Method

The sample size of this study was 988 (433 same-day and 555 after 7 days), which includes all eligible PLHIV who were newly diagnosed and started on ART between 20 October 2016 and 18 July 2018 at study sites.[20]

We calculated a required sample size of 427 study participants for both groups to be able to detect a 10% absolute difference in the proportion of individuals with optimal adherence between the two groups, based on results from studies conducted in the Amhara region of Ethiopia on self-reported optimal adherence among PLHIV who started ART before universal "test and treat" approach.[23,24] We used P_1 of 98% (proportion of PLHIV having optimal adherence among individuals in the same-day group) and P_2 of 88% (proportion of PLHIV having optimal adherence among individuals in the control group).[25] A 1:1 allocation with α of 0.05, 80% power, a design effect of 1.5 to account for the effect of clustering in multicenter design,[26] and a 15% allowance for anticipated limitations with regard to missing medical record data in Ethiopia[27] were used to calculate the sample size. We used StatCalc for cohort studies using Epi Info™ version 7 (developed by Centers for Disease Control and Prevention) to determine the sample size.

Statistical Analysis

Sociodemographic and clinical characteristics of study participants were summarized by group. Chi-square test was used to compare baseline and follow-up covariates between the two groups. We assumed the likelihood of a covariate data to be missing completely at random (MCAR) based on our knowledge of the data and the HIV program coupled with Little's chi-square MCAR test.[28] Because of this assumption and having a fairly large sample size that is higher than the minimum required sample, we used complete-case analysis. However, due to high proportion and differential missing data, we excluded baseline CD4 data during analysis. Accordingly, the final model for the adjusted analysis included 551 and 822 number of observations for the 6- and 12-months adherence assessments, respectively.

Proportions of individuals with optimal adherence at 6- and 12-months after ART initiation were compared with absolute risk difference (RD) between the two groups using a chi-square test. We estimated the adjusted optimal adherence using risk ratio (RR) with 95% confidence interval (CI) for each study group. In the adjusted analysis, we first balanced the two groups by estimating the propensity score using a logistic regression model[29,30] to adjust for the baseline covariates including age, sex, marital status, education, place of residence, BMI, WHO clinical stage, functional status and OI at enrollment. One observation was trimmed due to very low propensity score.

A doubly-robust multivariable logistic regression model that included both the propensity score and the baseline covariates were used to ensure sufficient covariate balance.[29,30] Additionally, other non-baseline covariates such as cotrimoxazole preventive therapy (CPT), isoniazid preventive therapy (IPT), type of ARV regimen initiated, disclosure of HIV status and partner's HIV status were included in the analysis. A cluster-robust standard error was used to account for the effect of clustering at health facility level.[31,32] Possible significant interaction terms between the main effect variables were checked for inclusion in the model. Model diagnostics were conducted for the final model that included the propensity score and all significant variables ($p<0.25$) using the Hosmer-Lemeshow goodness-of-fit test supplemented by c-statistics for the area under the receiver operator characteristic curve.[33] Adjusted RR with 95% CI was computed from the adjusted odds ratio after running the final logistic regression model.[34] All statistical analyses were performed using Stata version 13.0 (StataCorp., College Station, TX).

Ethics

Ethical clearance was obtained from the Institutional Review Board of the University of Gondar with Ref. No. V/P/RCS/05/2488/2019. The ethical clearance with the

protocol was shared to Amhara Public Health Institute for further clearance. The institute provided a support letter to town health offices requesting access to the medical records at study sites. Participants were not directly contacted nor were their personal identifiers collected. While reviewing patients' medical records, non-personal identifiers such as unique ART number or medical record number were used to distinguish study subjects. Only data collectors and supervisors had access to the medical records and both groups signed confidentiality agreements before commencing data collection. The study was conducted in accordance with the Declaration of Helsinki.

Results

Characteristics of Study Participants

Of the 988 medical records reviewed, 942 (95.3%) participants (415 PLHIV who started ART on the same-day of HIV diagnosis and 527 PLHIV who started more than 7 days after their HIV diagnosis) had documented clinician recorded ART adherence information at 6- or 12-months after initiating ART; and were included in the current analysis. Of the 942 participants, 96 (63 in the same-day group and 33 in the >7 days group) and 149 (87 in the same-day group and 62 in the >7 days group) were LTFU at 6- and 12-months, respectively, and assumed to have sub-optimal adherence.

Participants who were initiated on ART on same-day of and more than 7 days after HIV diagnosis were similar in educational status, marital status, religion and HIV status of their partner. The median age of participants was 31 (IQR 27.0–39.0) in the same-day and 33 (IQR 27.0–40.0) in the over 7 days group (p=0.04). Compared to the >7 days group, participants in the same-day group were more likely to be women (p=0.03), live within town (p=0.003), disclose their HIV status (p=0.001), have good (working) functional status (p<0.001), have missing baseline CD4 cell count (p<0.001), be at WHO clinical stage I (p<0.001), not be eligible for CPT (p<0.001), and take IPT (p<0.001) (Tables 1 and 2).

All participants (100%, n=415) in the same-day group were prescribed with a Non-nucleoside Reverse Transcriptase Inhibitors (NNRTI)-based first-line regimen (a fixed-dose combination (FDC) of Tenofovir (TDF) + Lamivudine (3TC) + Efavirenz (EFV)) compared to 96.2% (n=507) of the >7 days group (p<0.001). However, 11 individuals in the >7 days group had their regimen changed to a different first-line regimen, and 8 of the 11 had

Table 1 Sociodemographic Characteristics of Study Participants by Group in Bahir Dar and Gondar, Ethiopia, 20 October 2016–18 July 2018

Characteristics	Same-Day Group (n, %)	>7 Days Group (n, %)	P-value
Sex			0.03
Male	179 (43.1)	266 (50.5)	
Female	236 (56.9)	261 (49.5)	
Age in years – Median (IQR)	31 (27.0–39.0)	33 (27.0–40.0)	0.04
Educational status			0.06
No Education	102 (24.6)	147 (27.9)	
Primary	114 (27.5)	159 (30.2)	
Secondary	128 (30.8)	117 (22.2)	
Tertiary	47 (11.3)	70 (13.3)	
Missing	24 (5.8)	34 (6.4)	
Marital status			0.22
Never married	92 (22.2)	120 (22.8)	
Married	164 (39.5)	216 (41.0)	
Divorced/ separated	121 (29.2)	135 (25.6)	
Widow/er	23 (5.5)	22 (4.2)	
Missing	15 (3.6)	34 (6.4)	
Religion			0.73
Orthodox	371 (89.4)	482 (91.4)	
Protestant	3 (0.7)	3 (0.6)	
Muslim	36 (8.7)	38 (7.2)	
Missing	5 (1.2)	4 (0.8)	
Place of residence			0.003
Within town	355 (85.6)	405 (76.8)	
Out of town	59 (14.2)	119 (22.6)	
Missing	1 (0.2)	3 (0.6)	
Disclosure of HIV+ status[a]			0.001
Disclosed	284 (68.4)	308 (58.5)	
Not disclosed	49 (11.8)	57 (10.8)	
Missing	82 (19.8)	162 (30.7)	
HIV status of partner[a]			0.9
HIV negative	53 (12.8)	66 (12.5)	
HIV positive	96 (23.1)	110 (20.9)	
Unknown	42 (10.1)	54 (10.2)	
No partner	177 (42.7)	229 (43.5)	
Missing	47 (11.3)	68 (12.9)	
Functional status			<0.001
Working	404 (97.4)	467 (88.6)	
Ambulatory	11 (2.6)	45 (8.5)	
Bed ridden	0 (0.0)	13 (2.5)	
Missing	0 (0.0)	2 (0.4)	

Note: [a]In subsequent follow-up visits post-treatment initiation.
Abbreviations: HIV, human immunodeficiency virus; IQR, interquartile range.

Table 2 Bio-Clinical Characteristics of Study Participants by Group in Bahir Dar and Gondar, Ethiopia, 20 October 2016–18 July 2018

Characteristics	Same-Day Group (n, %)	>7 Days Group (n, %)	P-value
BMI — Median (IQR)	20.2 (18.4–22.4)	19.7 (17.7–22.0)	0.01
CD4 cell count/μL			<0.001
<200	52 (12.5)	206 (39.1)	
200–349	30 (7.2)	85 (16.1)	
≥350	79 (19.1)	96 (18.2)	
Missing	254 (61.2)	140 (26.6)	
WHO clinical stage			<0.001
Stage I	314 (75.7)	239 (45.3)	
Stage II	67 (16.1)	131 (24.9)	
Stage III	31 (7.5)	129 (24.5)	
Stage IV	3 (0.7)	28 (5.3)	
OI at enrollment			<0.001
Yes	32 (7.7)	126 (23.9)	
No	383 (92.3)	401 (76.1)	
CPT at 6-months[a]			<0.001
Yes	113 (27.2)	352 (66.8)	
No	28 (6.8)	12 (2.3)	
Not eligible	274 (66.0)	163 (30.9)	
CPT at 12-months[b]			<0.001
Yes	99 (23.9)	320 (60.7)	
No	35 (8.4)	38 (7.2)	
Not eligible	281 (67.7)	169 (32.1)	
IPT at 6-months[a]			<0.001
Yes	268 (64.6)	208 (39.5)	
No	130 (31.3)	259 (49.1)	
Not eligible	17 (4.1)	60 (11.4)	
IPT at 12-months[b]			<0.001
Yes	266 (64.1)	255 (48.4)	
No	126 (30.4)	216 (41.0)	
Not eligible	23 (5.5)	56 (10.6)	
ARV regimen started			<0.001
TDF + 3TC + EFV (FDC)	415 (100.0)	507 (96.2)	
AZT + 3TC + EFV	0 (0.0)	9 (1.7)	
Others	0 (0.0)	11 (2.1)	

Note: [a]Within 6-months of ART initiation. [b]Within12-months of ART initiation.
Abbreviations: ARV, antiretroviral; AZT, Zidovudine; BMI, body mass index; CPT, cotrimoxazole preventive treatment; FDC, fixed dose combination; EFV, Efavirenz; IPT, isoniazid preventive therapy; IQR, interquartile range; 3TC, lamivudine; OI, opportunistic infection; TDF, tenofovir; WHO, World Health Organization.

been switched to another first-line NNRTI-based regimen within 12-months of ART initiation (Table 2). Additionally, one person's ART in each group was changed to second-line ART within 12-months of ART initiation.

ART Adherence Outcomes at 6- and 12-Months of Follow-Up

As reported in Table 3, the proportion of study participants who reported optimal adherence at 6 months was significantly lower in the same-day group (75.1%, n=304) compared to the >7 days group (81.6%, n=425) with an absolute RD of 6.5% (95% CI: 1.1%, 11.9%; p=0.02). At 12 months, similarly, the proportion of study participants reported optimal adherence was significantly lower in the same-day (72.2%, n=292) compared to those initiated >7 days (78.1%, n=402) with an absolute RD of 6.8% (95% CI: 1.2%, 12.5%; p=0.02).

Compared to the >7 days group, the unadjusted and adjusted RR of 6-months optimal adherence for same-day group were 0.92 (95% CI: 0.86, 0.99; p=0.02) and 0.90 (95% CI: 0.86, 0.94; p<0.001), respectively. At 12 months, the unadjusted RR of optimal ART adherence for the same-day group was 0.91 (95% CI: 0.85, 0.99; p=0.02) compared to the >7 days group; the adjusted RR for this comparison was 0.89 (95% CI: 0.83, 0.95; p=0.001) (Table 4).

Discussion

In this study, we found that individuals who started ART on the same-day of HIV diagnosis had lower proportion of optimal ART adherence at 6-months and 12-months of ART follow-up compared to those who started ART more than 7 days after their HIV diagnosis. Similarly, in the adjusted analysis, same-day group had significantly lower optimal ART adherence compared to the >7 days group at 6- and 12-months post ART initiation.

We measured self-reported optimal adherence (≥95% adherence) using clinician assessment during routine clinical care follow-up. Our study found that PLHIV who started ART on the day of HIV diagnosis had a reduced optimal ART adherence at 6- and 12-months, compared to those who started ART more than 7 days after their HIV diagnosis. Our ART adherence results correlate with the lower viral suppression we found among same-day group in our previous publication that focused on virologic outcomes.[35] Viral load measurement has been used as

Table 3 ART Adherence Outcomes at 6- and 12-Months ART Follow-Up by Group in Bahir Dar and Gondar, Ethiopia, 20 October 2016–18 July 2018

Outcomes	No. (%) of Participants		Absolute RD, % (95% CI)	p-value
	Same-Day	>7 Days		
	(n=405)	(n=521)		
Optimal adherence at 6-months	304 (75.1)	425 (81.6)	6.5 (1.1, 11.9)	0.02
	(n=410)	(n=515)		
Optimal adherence at 12-months	292 (71.2)	402 (78.1)	6.8 (1.2, 12.5)	0.02

Abbreviation: RD, risk difference.

Table 4 Adjusted ART Adherence Outcomes for Same-Day ART Group in Bahir Dar and Gondar, Ethiopia, 20 October 2016–18 July 2018

Outcomes	Unadjusted		Adjusted†	
	RR*	95% CI	RR*	95% CI
Optimal adherence at 6-months[a]	0.92	(0.86, 0.99)	0.90	(0.86, 0.94)
Optimal adherence at 12-months[b]	0.91	(0.85, 0.99)	0.89	(0.83, 0.95)

Notes: *Reference group=persons initiated on ART >7 days after HIV diagnosis. †Multivariable logistic regression model included the propensity score and other covariates such as: [a]BMI, religion, disclosure, partner's HIV status, baseline WHO clinical stage, baseline OI, baseline functional status, CPT, IPT, ARV regimen and partner's HIV status#BMI. [b]Gender, educational status, marital status, place of residence, baseline OI, baseline functional status and IPT.
Abbreviation: RR, risk ratio.

another way of assessing ART adherence[36] — sometimes considered as the gold standard for monitoring ART adherence.[37]

Our finding was consistent with a recent observational study that evaluated the national scale-up of "test and treat" in Nigeria. This study highlighted that PLHIV who started ART within two weeks had <70% good adherence based on pharmacy refill data.[16] The lower optimal ART adherence among same-day initiators in our study could be directly related with the higher LTFU reported among same-day group at 6- and 12-months post-initiation of ART.[20] All LTFU individuals in this study were assumed to have sub-optimal adherence due to treatment interruption. These findings may indicate the need for intensified counseling and monitoring to PLHIV who started treatment on the initial date of HIV diagnosis.

Furthermore, the lower optimal ART adherence among same-day initiators could be related with failure to ensure the readiness of individuals for immediate ART initiation after a positive HIV diagnosis. Some individuals may need more time to comprehend the result and cope with the news of being HIV positive before deciding to start a lifelong treatment. Evidence from a randomized trial in South Africa and Kenya showed that, when given an option, only half of newly diagnosed PLHIV were eligible and ready for the same-day initiation of ART.[19] Therefore, preference to start ART on a later date may be one of the reasons for high rate of early treatment interruption among same-day initiators during "test and treat" era. For instance, in South Africa[18] and Haiti,[17] 35% and 20% of same-day initiators did not return to refill their ART after the initial ART dispensation, respectively, resulting in a phenomenon of "failed initiation" that program managers need to explore to understand and find resolutions for. Additionally, previous studies have showed that fear of drug side effects, inadvertent HIV status disclosure and discrimination[38] are few of the items that need to be addressed prior to ART initiation to ensure good ART adherence.

ART clinicians should provide adequate support to individuals to help them understand their result and its implication, and assess and address possible risk factors or barriers to treatment adherence[39,40] before putting PLHIV on immediate ART. Individuals who started ART on the same-day of HIV diagnosis should be prioritized for enhanced adherence counseling and follow-up especially during the early phase of treatment. Additionally, individuals with potential risk of suboptimal adherence should be linked for family-,[41] facility- or community-based adherence support systems.[42]

Our study was limited to secondary data available on medical records of PLHIV, and hence we could not address some important individual-level factors including social, psychological, behavioral and mental health issues, and other provider- and system-level independent factors that may affect ART adherence in low resource settings.[5] Incomplete information on some of the variables in the secondary data may also affect the analysis, though it was compensated with the large sample size we used compared to the minimum required size. In addition, we have excluded baseline CD4 result from the analysis due to differential missing data. However, according to a study in South Africa,[43] this may not have an effect on the result due to no evidence of association between baseline CD4 and ART adherence. Individuals who transferred their care to another facility within 12 months of ART initiation were excluded from the study due to lack of information about their outcomes. Since there was evidence of a higher chance of discontinuing treatment among transferred-out individuals[44] and with increased proportion of transferred-out cases among PLHIV who started ART under universal "test and treat" strategy,[16] especially among same-day initiators,[18] our optimal adherence estimates among same-day group may have been overestimated.

Despite these limitations, the strength of our study was its design. It is a multi-center study with a fairly large sample size that applied strict inclusion criteria to select participants to reduce selection bias. We used propensity scores to balance the two groups and conducted a doubly-robust method to ensure sufficient covariate balance[29,30] and generate unbiased estimates.

Conclusions

Individuals who started ART on the same-day of HIV diagnosis had lower optimal adherence at 6-months and 12-months of ART follow-up compared to those who started ART more than 7 days after their HIV diagnosis. Patient-centered health care provision that assesses possible barriers to ART adherence and provide support accordingly can ensure the benefit aimed by rapid ART initiation. PLHIV initiated on the same-day of HIV diagnosis should receive enhanced adherence counseling and follow-up and be linked to other adherence support systems.

Abbreviations

AIDS, Acquired Immunodeficiency Syndrome; ART, Antiretroviral Therapy; ARV, Antiretroviral; AZT, Zidovudine; CPT, Cotrimoxazole Preventive Therapy; FDC, Fixed Dose Combination; HIV, Human Immunodeficiency Virus; IPT, Isoniazid Preventive Therapy; LTFU, Loss to Follow-up; NNRTI, Non-nucleoside Reverse Transcriptase Inhibitors; OI, Opportunistic Infections; PLHIV, People Living with HIV; 3TC, Lamivudine; TDF, Tenofovir; WHO, World Health Organization.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Author Contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests.

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