

Original Research Article

Predictors of antiretroviral therapy interruption on community viral load among people living with HIV in Siaya County, Kenya

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ABSTRACT

Background: Community viral load (VL) suppression is essential for assessing HIV treatment effectiveness, uptake, and impact on new HIV infections. Siaya is among the highest HIV burdens County in Kenya, with a prevalence rate of 13.2%, representing 96,297 estimated people living with HIV (PLWHIV). Among retained clients, 90% were virally suppressed, accounting for 51% of estimated PLWHIV.

Methods: This cross-sectional, retrospective, and qualitative study was conducted in Gem sub-County of Siaya County, Western Kenya, among re-engaged PLWHIV who interrupted treatment. Data was collected from 13 facilities with highest rates of treatment interruption between January 2017 and December 2022. Participants with shorter appointments were interviewed during clinic visits. Their prospective and retrospective data were merged and analyzed using Chi-square, Fisher's exact tests, Kaplan-Meier, and Cox proportional hazard models to evaluate associations between demographic, cultural, and socioeconomic characteristics and VL suppression.

Results: Of 311 participants assessed, median was age 45 years (IQR: 37–52) and VL suppression rate of 55%. Clients with primary education had lower non-suppression rates than those with university education (HR 0.45; 95% CI, 0.26–0.76), and non-suppression was higher among those in formal employment compared to business (HR 1.95; 95% CI, 1.07–3.53). PLWHIV on ART for over 24 months had lower non-suppression rates (HR 0.5; 95% CI, 0.35–0.73) than those on ART for under 12 months.

Conclusions: University education, formal job, or being on ART for less than 12 months increased the risk of attrition. Implementation of client-centred HIV services may improve community VL suppression.

Keywords: ART, Community, Interruption, Non-suppression, Suppression, Viral-load

INTRODUCTION

It has been suggested that community viral load suppression, is an aggregate of individual viral loads of people living with HIV in a certain community.¹ This is a useful indicator that is used to quantify viral load for a certain region or community. It is expected therefore that, this metric indicator could be used to measure antiretroviral exposure and the effect of treating HIV-1-infected individuals on HIV transmission.¹ Kenya like the

rest of sub-Saharan countries, accounts for over 52.1% of the estimated total of 39.9 million people infected with HIV-1 worldwide.²

UNAIDS revealed that among 89% estimated people living with HIV (PLWHIV) accessing HIV treatment only 83% are virally suppressed and this accounts for only 72% of the estimated PLWHIV worldwide.² Therefore, the efforts of using Antiretroviral therapy (ART) as a means of preventing new HIV infections is

relatively less successful, especially in low- and middle-income countries (LMIC).³

Studies across the globe demonstrate that increasing population-level antiretroviral (ARV) medication exposure results in significant drops in HIV-related morbidity and mortality as well as lower rates of new HIV infections.⁴ ART compliance at the optimal level (adherence to ART >95%) is directly related to undetectable HIV viral loads among PLWHIV, placing HIV disease in remission, and preventing further transmission.⁵ HIV Treatment-As-Prevention (TasP) programs offer prompt and universal access to ART medication and improves HIV testing and retention to care, with the goal of reducing viral transmission at the individual and community levels.⁶

In Kenya, the HIV prevalence has been estimated at 3.2% with approximately 1.4 million PLWHIV.^{2,7} HIV prevalence has been estimated to be 13.2% in Siaya County with approximately 96,297 PLWHIV.⁸

According to a study by, ART interruptions; stopping ART for more than 28 days, make TasP less effective by increasing the likelihood of viral drug resistance development, viral load rebound, and morbidity associated with HIV.⁴

ART treatment interruption, including viral load suppression, is a crucial determinant in HIV treatment efficacy.⁹ Siaya county is not an exception because it has the highest HIV burden in Kenya, but statistics from LMICs suggest that as ART programs mature and more individuals begin taking ART, the proportion of persons who are lost to follow-up (LTFU) increases.⁷

High community viral suppression depends on mopping up all HIV infected clients, initiating them on ART and retaining them on treatment to attain viral load suppression.¹⁰ The international community and national AIDS programs have estimated the levels of service coverage required to achieve HIV epidemic control at 95-95-95.^{11,12} However, the achievement of the 3rd 95 (viral load suppression and survival) is mostly affected by the high incidence of ART treatment interruption and sub-optimal ARV adherence which are also a relevant programmatic indicator for other patient clinical outcomes.^{7,13,14}

METHODS

This was a mixed method; cross-sectional, retrospective, and qualitative study carried out within 13 health facilities sampled in the Gem Subcounty of Siaya County. Data was collected from recruited 311 PLHIV who had experienced an interruption in HIV treatment between January 2017 to December 2022 and 13 lead adherence officers deployed in various comprehensive clinic centre (CCC) as Key Informant interview (KII). The trained research assistant extracted retrospective data into a checklist and prospective data into an electronic

questionnaire designed on a mobile app (Kobo) to centralize the data collected from various facilities. The key informant interview guide was used to collect qualitative data from the adherence officers. The main outcome variables were viral load suppression and time on ART to interruption in treatment. The independent variables were demographic characteristics, cultural practices, socio-economic factors, and a moderating variable on government policy and guidelines such as service access and coverage, support to PLWHIV, Medication management, coordination of care, and patient tracking.

Siaya County was chosen for the study because it is the third-highest HIV-1 prevalence at 13.2% in Kenya, 2,8 and Gem Sub County because it was one of the regions with the highest numbers of PLWHIV experienced ART interruptions in the County.⁸ Health facilities with highest proportion (>3%) of PLWHIV aged above 18 years who were initiated ART between January 2017 to December 2022 and interrupting treatment for more than 28 days but reengaged in treatment by the time of data collection were included in the study. The sampled and consented PLWHIV were interviewed as they came for their scheduled routine clinic appointment until a sample size for that specified facility was attained. In addition, lead key informants (adherence officers) deployed in the comprehensive care clinics within the selected health facilities were interviewed.

The retrospective and prospective data were merged and analysed using R version 4.4.0. The result was summarized and presented using median, frequency and response percentages and categorized as either virally suppressed and non-suppressed. Chi-square test and fisher's exact test were used to determine the association between the outcome and explanatory variables. The predictors of virologic failure were evaluated using unadjusted Cox proportional hazards models. Time to viral load non-suppression and time from ART initiation to ART interruption were estimated by the Kaplan–Meier curve. To address the study questions, the significance of the association was established using p values and confidence interval at the 5% level of statistical error.

RESULTS

Demographic characteristics of study participants

The result shows that 55% of the PLHIV experiencing interruption in treatment were virally suppressed (viral load of <200 copies/ml of blood), suggesting that interruption in treatment may be the predisposing factor to low community viral load suppression. The median age of the study participants was 45 years, with an interquartile range of 37 to 53 years. When comparing the age of the non-suppressed and suppressed clients, the median ages were nearly similar at 43 years and 45 years, respectively. The majority of participants (156) were aged between 35 and 49 years, followed by those aged 50 years and above (113). However, most (56%) of the non-

suppressed clients were in the age category of 18-24 years followed closely by 25-35 years at 48%. The study participants composed of 62% females and 38% males. The proportions of females and males were the same in both the non-suppressed and suppressed groups, with 45% being non-suppressed and 55% being suppressed. The sample sizes across the different marital status categories vary, with the largest groups being "Married monogamous" (n=183). Individuals in polygamous marriages showed the highest proportion (78%) of virally suppressed clients. In contrast, individuals who are single (48%) or in monogamous marriages (51%) have lower rates of viral load suppression. The analysis shows that, 64% of the PI-based regimen participants were virally non-suppressed while only 44% of the DTG-based regimen participants were virally non-suppressed. Findings demonstrates that clients with a college or university education had the highest proportion (68%) of non-suppression viral load compared to those with lower

educational levels. The study established that the further the distance to the healthcare facility, the higher the likelihood of non-suppression which is 57% for clients residing more than 20km from the facility compared to the non-suppression of less than 43% for those residing in a radius of less than 3Kms. This underscores the importance of geographic accessibility to healthcare services in maintaining the required (95%) viral load suppression to achieve community viral load suppression after treatment interruptions. The findings also revealed differences in viral load suppression based on the source of income among the clients who experienced interruption in treatment. The PLHIV in formal employment and casual employment had the highest proportion (63% and 50%) respectively of virally non-suppressed while those engaged in business (63% suppressed) and farming (60% suppressed) had better viral load outcomes (Table 1).

Table 1: Demographic characteristics of study participants.

Variable	N	Non-suppressed (%)	Suppressed (%)	P value
N	311	141 (45)	170 (55)	
Age median (IQR)	45 (37,53)	43 (37, 53)	45 (38, 52)	0.50
Sex				
Female	192	87 (45)	105 (55)	0.99
Male	119	54 (45)	65 (55)	
Age category in years				
18-24	9	5 (56)	4 (44)	0.90
25-34	33	16 (48)	17 (52)	
35-49	156	69 (44)	87 (56)	
50+	113	51 (45)	62 (55)	
Marital status				
Single	23	12 (52)	11 (48)	0.09
Married monogamous	183	90 (49)	93 (51)	
Married polygamous	27	6 (22)	21 (78)	
Divorced	7	3 (43)	4 (57)	
Widowed	71	30 (42)	41 (58)	
Highest education level				
Primary incomplete	47	20 (43)	27 (57)	0.01
Primary complete	82	28 (34)	54 (66)	
Secondary incomplete	38	19 (50)	19 (50)	
Secondary complete	104	47 (45)	57 (55)	
College/university	40	27 (68)	13 (33)	
Source of income				
Business	49	18 (37)	31 (63)	0.03
Casual employment	64	32 (50)	32 (50)	
Farming	137	55 (40)	82 (60)	
Formal employment	48	30 (63)	18 (38)	
Unknown	13	6 (46)	7 (54)	
ART regimen				
DTG	289	127 (44)	162 (56)	0.07
PI Based	22	14 (64)	8 (36)	
Time from ART Initiation to ART interruption				
<12 months		48 (67)	24 (33)	<0.01
13-24 months		23 (45)	28 (55)	
24+ months		70 (37)	118 (63)	

Table 2: Socio-economic factors influencing viral load suppression among PLWHIV.

Variable	N	Non-suppressed (%)	Suppressed (%)
Cost of a fare contributes to ART interruption among PLHIV			
Strongly agree	113	55 (49)	58 (51)
Agree	162	67 (41)	95 (59)
Neutral	18	9 (50)	9 (50)
Disagree	17	9 (53)	8 (47)
Strongly disagree	1	1 (100)	0 (0)
Strongly disagree	4	1 (25)	3 (75)
Type of economic activity influences ART interruption			
Strongly agree	90	44 (49)	46 (51)
Agree	189	80 (42)	109 (58)
Neutral	23	11 (48)	12 (52)
Disagree	9	6 (67)	3 (33)
Type of economic activities that exposures client to IIT			
Business	29	15 (52)	14 (48)
Casual employment	120	56 (47)	64 (53)
Farming	11	5 (45)	6 (55)
Fishing	71	32 (45)	39 (55)
Formal employment	76	31 (41)	45 (59)
I don't know	4	2 (50)	2 (50)

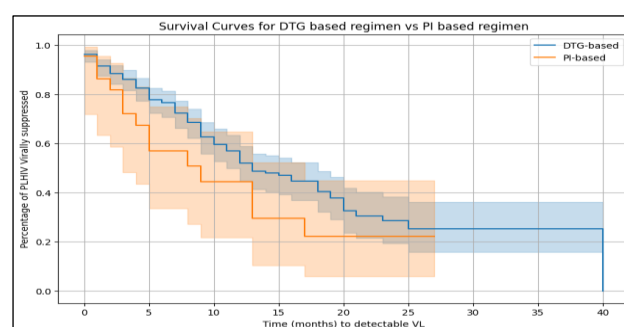
Socio-economic factors influencing viral load suppression among PLWHIV

The study investigated client perception on other socio-economic factors influencing viral load suppression among the PLHIV experiencing interruptions in treatment. The results showed the association between Cost of travel and type of economic activity, their influence on viral load suppression among PLHIV experiencing interruptions in treatment. The findings revealed that, participants who strongly agreed or agreed that the cost of travel contributes to ART interruption had a lower rate of viral load non-suppression (49% and 41%, respectively) compared to those who disagreed (53%) or strongly disagreed (100%). The results also reveal that the type of economic activity the clients were engaged in may impact their ability to maintain consistent ART treatment. PLWHIV who strongly agreed or agreed that the type of economic activity influences ART interruption had a lower rate of viral load non-suppression (49% and 42%, respectively) compared to those who disagreed (67%). Specifically, the PLWHIV involved in business activity had a higher rate of viral load non-suppression (52%) compared to those in formal employment at 41% (Table 2).

Time to non-viral load suppression among PLWHIV on DTG or PI based ART regimen

Survival distribution reveals that there was no significant difference on viral load suppression between PLHIV experiencing interruption on treatment on DTG based ART regimen and those on PI based. However, the clients on PI based ART regimen are more likely to non-

suppress (HR 1.55, 95% CI, 0.89-2.69) compared to those on DTG based ART regimen (p value>0.05). On the survival distribution curve, it was observed that the percentage of PLHIV on a PI based virally suppressed drops very faster and at the 17th month, nearly only 20% of the clients may sustain viral load suppression compared to those on DTG based regimen that were likely to sustain nearly 40% of the clients virally suppressed up to estimated median time of 20 months (Figure 1).

**Figure 1: Time to non-viral load suppression among PLHIV on DTG-based or PI-based ART regimen.**

Time on ART to interruption in treatment by viral load suppression among PLWHIV

The survival distribution curves for time on ART also, revealed that clients who had been on ART for more than 24 months were likely to sustain a significantly higher viral load suppression (HR 0.58, 95% CI, 0.35-0.97) compared to those who had been on ART for less than 12 months (P value <0.001). The study found out that the

proportion of virally suppressed PLWHIV who had been on ART for less than 12 months drops faster and at 20th month, least than 20% of the clients were virally suppressed compared to nearly 40% viral load suppression among those who had been on ART for more than 24 months at estimated median time of 20 months (Figure 2).

Relationship Between socio-economic factors and viral load suppression among PLWHIV experiencing interruption in treatment

We performed a Cox proportional hazard model to assess the statistical significance on the relationship between socio-economic factors and the level of viral load suppression among PLWHIV experiencing interruptions in treatment. From the analysis, the virally non-suppression was lower among PLWHIV who had completed primary education compared to those with College or University education (HR 0.45; 95% CI, 0.26-0.76; $p<0.05$). In addition, virally non-suppression was

higher among PLWHIV in formal employment compared to those engaged in business as a source of income (HR 1.95; 95% CI, 1.07-3.53; $p<0.05$). Therefore, result shows that the level of education and source of income have a statistically significant impact on viral load non-suppression among PLWHIV experiencing an interruption in treatment (Table 3).

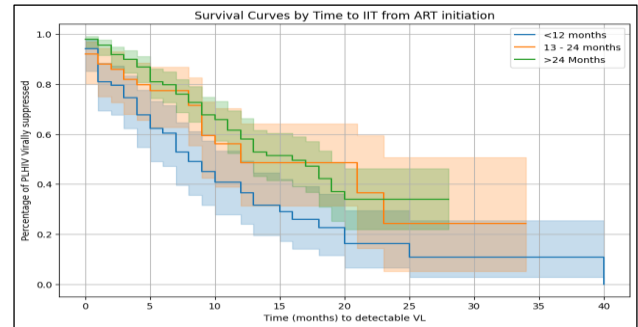


Figure 2: Time on ART to interruption in treatment by viral load suppression among PLWHIV.

Table 3: Relationship between socio-economic factors and viral load suppression among PLWHIV.

Variable	HR	95% CI	P value
Sex			
Female	ref		
Male	0.84	0.59, 1.19	0.3
Age category in years			
18-24	ref		
25-34	0.58	0.21, 1.61	0.3
35-49	0.60	0.24, 1.48	0.3
50+	0.64	0.25, 1.60	0.3
Marital status			
Divorced	ref		
Married monogamous	1.38	0.44, 4.38	0.6
Married polygamous	0.57	0.14, 2.26	0.4
Single	1.52	0.42, 5.46	0.5
Widowed	1.30	0.40, 4.27	0.7
Highest education level			
College/university	ref		
Primary complete	0.45	0.26, 0.76	0.003
Primary incomplete	0.76	0.43, 1.36	0.4
Secondary complete	0.64	0.39, 1.03	0.065
Secondary incomplete	0.85	0.47, 1.53	0.6
Source of income			
Business	ref		
Casual employment	1.47	0.81, 2.66	0.2
Farming	1.16	0.67, 2.01	0.6
Formal employment	1.95	1.07, 3.53	0.029
ART regimen			
DTG	ref		
PI Based	1.55	0.89, 2.69	0.12
Time to IIT from ART initiation			
<12 months	ref		
13 - 24 months	0.57	0.34, 0.95	0.031
24+ months	0.5	0.35, 0.73	<0.001

DISCUSSION

The demographic analysis provides insights into the characteristics of people living with HIV (PLWHIV) who have experienced interruptions in (ART) treatment and viral load suppression. In this study, of the PLWHIV experiencing interruption in treatment about 170 (55%) of them had viral suppression. This suggests that interruption in treatment could be a significant factor contributing to lower community viral load suppression, even though over half of those with interruptions were able to maintain viral suppression.

This finding was in support in regards to 95-95-95 target indicating that globally, among all estimated PLWHIV, only 86% knew their status, 89% were accessing treatment and 83% were virally suppressed.^{2,7,8} This study concurs with previous studies which have shown 51% VL suppression among estimated PLWHIV compared to 90% VL suppression of the retained PLWHIV on ART in Siaya County.^{14,15} Therefore, with this high proportion of PLWHIV with detectable community viral load, the effort to attaining the targeted (95%) community VL suppression would be relatively less successful.¹⁶

The study's participants were more likely to be female (62%), which supports the finding that women bear a disproportionately greater HIV burden in most contexts. As a result, gender was recognized as one of these factors. Previous studies indicate that in Kenya, males are more likely than females to discontinue HIV treatment in most settings.¹⁷ Men's poor health-seeking behaviour is linked to this finding, which results in advanced HIV illness at the time of ART initiation and worse treatment adherence among men in most contexts. In contrast to this study, the proportions of females and males were the same in both suppressed and non-suppressed (55%) and (45%) groups respectively. This finding implies that viral load suppression was not solely associated with gender. The median age of the study participants was nearly similar at 43 years and 45 years for both non-suppressed and suppressed clients. Though the viral load suppression rate was the lowest (44%) among the participants aged 18-24 years, though it was still low across all age categories compared to the UNAIDS target (95%). The finding was similar to Ekstrand et al which indicated that ART interruption is common among several important populations, including adolescents, young adults, and drug users (PWUD).⁴ Therefore, the study findings suggest that age alone is not a significant factor in determining the viral load suppression among the PLWHIV interrupting treatment. Thus, the interventions and support to improve treatment outcomes should not be targeted specifically based on age, as other socio-demographic, clinical, or behavioural factors may be more important in influencing interruption in treatment and viral load suppression. The results emphasize the importance of ensuring access to and continuity of HIV care among PLWHIV of all age groups, as they may

achieve similar levels of low viral load suppression when they interrupt treatment.

According to study findings, the highest proportion of virally suppressed clients was found among those in polygamous relationships as opposed to those who were single or in monogamous partnerships. This finding was contrary to previous studies, which found that ineffective community customs like polygamy can encourage unfaithfulness and lack of trust, and those individuals who adhere too strongly to these practices equally do not adhere to the hospital appointment.^{18,19}

The study determined the viral load suppression rates among PLWHIV ever experienced interruptions in HIV treatment and their similarity with community viral load suppression. The key finding is that only 55% of the clients who experienced interruption in treatment were virally suppressed and those within the first 12 months of antiretroviral treatment (ART) had a higher rate of non-suppression compared to those who interrupted after 13 months or more (45% non-suppressed) on treatment. This highlights the importance of supporting naïve clients, especially during the initial months of ART, to maintain optimal adherence and avoid treatment interruptions. This could involve enhanced adherence counselling, treatment literacy, close monitoring, and proactive management of side effects. This result is similar to a previous study that revealed that an interruption in antiretroviral therapy (ART) can lead to increased viral load and the development of drug resistance, which can compromise the effectiveness of future treatment regimens.^{18,21}

Furthermore, the findings suggest that strengthening patient education on the importance of ART and timely viral load monitoring could help mitigate the impact of treatment interruptions on viral suppression. Higher rates of viral load suppression were observed among clients who strongly agreed or agreed that ARVs are important and that treatment interruption is caused by stigma and unfriendly healthcare workers. The finding therefore implies that providing PLWHIV with comprehensive information about their HIV treatment, the importance of adherence, and the potential side effects, is crucial for empowering patients and promoting treatment success. Therefore, improved treatment literacy has been associated with better adherence, viral suppression, and overall health outcomes.²²

The study findings highlight several socio-economic factors that influence viral load suppression among PLWHIV experiencing interruptions in treatment. In this study, education levels influenced negatively with individuals with higher education having high viral loads. This finding appears contrary to the expected viral suppression among people with higher education hence better health outcome. However, this negative outcome could be related to differences in healthcare-seeking behaviours, social support, or access to resources among

higher-educated PLWHIV. The finding contradicts study that established individuals with higher educational attainment are more likely to have a better understanding of HIV treatment, the importance of ART and the consequences of non-adherence.^{23,24}

The study also found out that source of income or livelihood influence treatment interruption. The PLWHIV engaged in formal employment and casual labour had the highest proportions of virally non-suppression rate, while those in business and farming had better viral load suppression. This implies that there is an impact of costs associated with HIV care and treatment on ART discontinuation. Despite the decentralization and availability of free ART, some PLWHIV & HIV exposed infant continues to drop out of care, posing the risk of developing drug resistance.^{21,25} This suggests that the financial burden of accessing HIV services is as a result of long distances, even when treatment is nominally free, can still act as a barrier to consistent ART adherence.

CONCLUSION

This study shows that HIV treatment interruption and community viral load control were significantly impacted by the clients' economic activity, treatment discontinuation for being on ART for less than 12 months, and levels of education. To improve treatment outcomes and maintain suppressive community viral load, there is a need to have client-centred clinic consultations, improved adherence, counselling, and tailored treatment literacy.

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Ethical approval: This study was granted ethical approval by Kenyatta University Ethical Review committee and the permit by National commission for science Technology and innovation (NACOSTI). In addition, permission was also granted by Siaya County Department of Health and County administration and community leadership (Chiefs, assistant chiefs, village elders and the respective health facility management committee). Each participant was consented by signing the consent form at enrolment. For participants who could not read or understand, a qualified and experienced counsellor explained the information verbally in local dialect for easy understanding

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