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A Retrospective Cross-Sectional Study on the Prevalence and Factors Associated with Virological Non-Suppression among HIV-Positive Adult Patients on Antiretroviral Therapy in Woliso Town, Oromia, Ethiopia

Teka Haile, Behailu Hawulte, Solomon Alemayehu

***Abstract*—**Background: HIV virological failure still remains a problem in HV/AIDS treatment and care. This study aimed to describe the prevalence and identify the factors associated with viral non-suppression among HIV-positive adult patients on antiretroviral therapy in Woliso Town, Oromia, Ethiopia. Methods: A retrospective cross-sectional study was conducted among 424 HIV-positive patient's attending antiretroviral therapy (ART) in Woliso Town during the period from August 25, 2020 to August 30, 2020. Data collected from patient medical records were entered into Epi Info version 2.3.2.1 and exported to SPSS version 21.0 for analysis. Logistic regression analysis was done to identify factors associated with viral load non-suppression, and statistical significance of odds ratios were declared using 95% confidence interval and p-value < 0.05. Results: A total of 424 patients were included in this study. The mean age (± SD) of the study participants was 39.88 (± 9.995) years. The prevalence of HIV viral load non-suppression was 55 (13.0%) with 95% CI (9.9-16.5). Second-line ART treatment regimen (Adjusted Odds Ratio (AOR) = 8.98, 95% Confidence Interval (CI): 2.64, 30.58) and routine viral load testing (AOR = 0.01, 95% CI: 0.001, 0.02) were significantly associated with virological non-suppression. Conclusion: Virological non-suppression was high, which hinders the achievement of the third global 95 target. The second-line regimen and routine viral load testing were significantly associated with virological non-suppression. It suggests the need to assess the effectiveness of antiretroviral drugs for epidemic control. It also clearly shows the need to decentralize third-line ART treatment for those patients in need.

***Keywords*—**Virological non-suppression, HIV-positive, ART, Woliso Town, Ethiopia.

I. Introduction

THE global public health community has set ambitious targets to end the HIV/AIDS pandemic by 2030. In line with the notable absence of a cure, the goal of HIV treatment is to achieve sustained viral suppression, which allows for better immunological recovery and reduces the risk of ongoing HIV transmission [1]-[3]. Routine monitoring of HIV viral load in people living with HIV is therefore the core to maintain the effectiveness of ART as well as monitoring the progress toward achieving the targets for viral suppression [4]. The success of universal ART for an AIDS free generation depends on the adherence of individuals to ART during early initiation of treatment [5].

Viral suppression is the primary marker of HIV treatment and care success. The incidence of cancer in HIV positive compared to HIV uninfected persons was highest for unsuppressed persons, lower among persons with early suppression, and also lower among those with long-term suppression [6]. In Kenya, 61.2% of HIV-infected people aged 15-64 years had not achieved virological suppression, and timely initiation of ART and retention in care are crucial for the prevention of transmission of HIV through durable viral load suppression [7]. From a study in South Africa, the rates of viral suppression were higher than rates of viral non suppression [8]. Improved virological outcomes following first-line failure was achieved with protease inhibitors based second line regimen ART in both adult and pediatric patients in rural South Africa [9]. On the other hand, increased second-line ART failure rate narrows the future HIV/AIDS treatment options in counties with limited resources, especially in sub-Saharan Africa [10].

In Vietnam, there was a high level of virological suppression and a low prevalence of HIV drug resistance among individuals who received ART for at least 36 months [11]. In Malawi, HIV viral non-suppression was associated male gender and stigma, while social support and self-efficacy were protective [12]. Similarly, in Uganda, young age group, poor adherence to ART and having active tuberculosis, had increased odds of viral non-suppression, while second/third-line ART regimens were protective against viral non-suppression [13]. Likewise, younger age, self-reported ART non-adherence and low CD4+ T-cell count on ART initiation were associated with a higher risk of virological failure [14]. Different HIV transmission risk minimizing strategies like viral load testing rates patients unlikely to be sexually infectious if their viral load under effective therapy is durably suppressed during six months and no other sexually transmitted infections are present [15].

Teka Haile is with the Department of HIV Prevention and Control, Woliso Town Health Office, Woliso Town, Oromia, Ethiopia (Corresponding author: Teka Haile, phone: +251923118260, e-mail: tekahaile22@gmail.com).

Behailu Hawulte is with the School of Public Health, College of Health and Medical Science, Haramaya University, Harar, Ethiopia.

Solomon Alemayehu is with the St. Luke Catholic General Hospital and College of Nursing and Midwifery, Woliso Town, Oromia, Ethiopia.

With increased adherence to ART, pregnant women who were receipt of Non Nucleotide Reverse Transcriptase Inhibitors (NNRTI)-based regimen and lower baseline HIV viral load were significant predictors of earlier time to achieve viral suppression and increased baseline CD4 count was statistically significant as a predictor of earlier time to achieve viral suppression [16].

Sustained virological suppression enables HIV-positive patients to live longer, healthier lives and reduce the probability of transmitting the virus [17]. Disclosure of HIV status may be linked to improved health outcomes for people living with HIV [18]. Adherence of around 67% was low for reliable viral suppression and accounts for the low viral suppression among HIV-positive mothers studied, in absence of any other factors [19].

Despite the benefits of ART, the incidence rate of virological failure was high in Ethiopia [20]. Despite limited resources in the setting, virological efficacy can be sustained for a substantial length of time and also enhance immunological recovery irrespective of age [21]. Factors like low baseline CD4+ T cell count, poor adherence, urban residence, cotrimoxazole preventive therapy (CPT) and Nevirapine (NVP)-based first-line drug regimen were associated with virological failure [22], [23]. Another study in East Shewa showed that plasma viral load suppression was lower (72%) in individuals taking a different regimens of ART and factors affecting time to suppression level were marital status and baseline CD4 [24]. The number of patients using second-line ART has increased over time as 1.5% of HIV-infected patients on ART are using a second-line regimen and little is known about its effect in this setting [25].

Very few studies have been conducted on the prevalence and factors associated with virological non-suppression among HIV positive adult patients on ART in Ethiopia, and none explicitly identified in Woliso Town. Therefore, this study described the prevalence and identified factors associated with virological non-suppression among HIV-positive adult patients on ART.

II. Materials and Methods

A. Study Design, Setting and Population

A health facility based retrospective cross-sectional study design was conducted in Woliso Town, Oromia, Ethiopia. The source population was people living with HIV who were currently receiving ART in Woliso town health facilities. The study population was adult patients attending ART who were on ART for at least six months with documented viral load result. Woliso Town is the capital of South West Shewa Zone, which is 114 km from Addis Ababa, on the road from Addis Ababa to Jimma. The town has two health centers and one general hospital, while two of the health facilities are providing ART services. A total of 2,401 people living with HIV were receiving ART at health facilities in the town. The study was conducted from August 15, 2020 to October 30, 2020.

B. Inclusion and Exclusion Criteria

All adult HIV patients attending ART clinic for care and treatment those who stayed for at least six months in ART care with documented viral load in Woliso town health facilities were considered for the study. Those adult patients attending ART clinic for care and treatment with undocumented viral load in Woliso town health facilities were excluded from the study.

C. Sample Size Determination and Sampling Procedure

The sample size was estimated using the formula for a single population proportion, $n = (z\alpha/_2)^2 p(1-p)/(d)^2$, by considering the following parameters: 61.2% detectable HIV viral load in Kenya: data from a population-based survey [7], 95% confidence level, 5% margin of error (α), and 0.05 degree of precision (d). Then, the total sample size for this study was 424.

From the total of three public health facilities in the town, two health facilities providing ART in the town were included in this study. Then the sample was proportionally allocated to both selected public health facilities based on the total number of clients attending ART clinic. The participants were selected from a prepared sampling frame and using a simple random sampling technique.

D. Data Collection Methods

Data were collected through reviewing patient's medical records using structured checklist. The checklist is developed through extensive review of the literature and consists of sociodemographic and clinical characteristics of the study participants containing independent variables like: sociodemographic data (age, gender, marital status, and residence), health facility type, clinical data (WHO staging, ART adherence, treatment, baseline CD-4 count and reason for determining viral load). The dependent variable was Viral Load result, which was part of the structured checklist. The source of the data was from all people living with HIV, enrolled in ART care for at least six months whose viral load result was documented on the client file during the study period. The study was done among 424 patients who had complete data on sociodemographic, clinical and viral load data.

E. Operational Definitions

- Good adherence: ART drug adherence of ≥ 95% of prescribed doses.
- Fair Adherence: ART drug adherence of 85–94% of prescribed doses.
- Poor Adherence: ART drug adherence of < 85% of prescribed doses.
- Viral load non-suppression: Elevated viral load in RNA copies of ≥ 1,000 per ml in plasma in a patient who has been on ART for at least six months.
- Routine viral load testing: Regular viral load measurement at regular intervals for all patients on ART to monitor response to treatment and for early detection of treatment failure.

- Targeted viral load testing: Viral load testing used to confirm treatment failure when suspected by immunological, clinical and initial virological criteria.

F. Data Quality Assurance

Before the data collection, the data collectors were trained for half day and practiced on the checklist further clarification. During data collection, data collectors were closely supervised. The collected data were checked for consistency and completeness of the response. Data coding was developed and double entry was done to ensure the quality of data. During the data analysis the normality of the data set was checked by histogram and normal probability plots.

G. Data Analysis Procedures

Data collected using structured checklist were entered into Epi Info™ version 7.2.3.1 and exported to Statistical Package for Social Sciences (SPSS) version 21.0 software for analysis. Data were quantitatively analysed and done by running frequencies and percentages to estimate the proportion of patients with viral non-suppression in the univariate analysis. Bivariate analysis was used for cross tabulation of categorical data and to examine association between selected exposure variables and outcome variable. All variables with $p < 0.2$, in bivariate analysis were entered into multivariate analysis in binary logistic regression to identify factors independently associated with viral non-suppression and for controlling potential confounding factors. The significance of odds ratios was determined with 95% CI and $p < 0.05$.

H. Ethical Considerations

Ethical approval was obtained from the Ethical and Research Review Committee of St. Luke Catholic General Hospital and College of Nursing and Midwifery (Ref.1230/20, issued on September 01, 2020). Official letter of permission to use the data was submitted to St. Luke Catholic Hospital and College of Nursing and Midwifery and Woliso Health Center. Since the study utilizes data from patient medical records, confidentiality of patient information was ensured as the names of study participants were not included in the data collection checklist. The data used for this study were not accessible by any other third party. All data were anonymized and informed consent was waived from the committee.

III. Results

A. Socio-Demographic Characteristics

A total of 424 patients were included in this study. The mean age (± SD) of the study participants was 39.88 (± 9.995) years. Among 424 study participants, the majority 275 (64.9%) were females while the rest 149 (35.1%) were males. Among 275 female patients, nine (3.3%) were pregnant mothers while 34 (12.4%) were lactating mothers. Around 275 (64.9%) were from urban residence and the rest 149 (35.1%) of the patients were from rural area. Regarding their marital status, 43 (10.1%) were unmarried, 277 (65.3%) married, 49 (11.6%) divorced and 55 (13.0%) were widowed. The majority 271 (63.9%) were from Orthodox religion, while the rest were 109 (25.7%) Protestant, five (1.5%) Catholic, 37 (8.7%) Muslim and two (0.5%) were other religion followers. Regarding the health facility type, around 274 (64.6%) were from the General Hospital while the rest 150 (35.4%) were from the Health Center (Table I).

TABLE I
SOCIO-DEMOGRAPHIC CHARACTERISTICS OF HIV-POSITIVE ADULT PATIENTS ON ART IN WOLISO TOWN, OROMIA, ETHIOPIA (N = 424)

Variables		Viral Load Suppression Status		Total n (%)
		VL <1000 RNA copies/ml n (%)	VL ≥1000 RNA copies/ml n (%)	
Gender	Female	243 (65.9%)	32 (58.2%	275 (64.9%)
	Male	126 (34.1%)	23 (41.8%)	149 (35.1%)
Pregnant mother	No	235 (85.5%)	31 (11.3%)	266 (96.7%)
	Yes	8 (2.9%)	1 (0.4%)	9 (3.3%)
Lactating mother	No	211 (76.7%)	30 (10.9%)	241 (87.6%)
	Yes	32 (11.6%)	2 (0.7%)	34 (12.4%)
Age category	15-19	10 (2.7%)	2 (3.6%)	12 (2.8%)
	20-24	9 (2.4%)	1 (1.8%)	10 (2.4%)
	25-29	23 (6.2%)	5 (9.1%)	28 (6.6%)
	30-34	65 (17.6%)	8 (14.5%)	73 (17.2%)
	35-39	92 (24.9%)	11 (20.0%)	103 (24.3%)
	40-44	57 (15.4%)	11 (20.0%)	68 (16.0%)
	45-49	53 (14.4%)	10 (18.2%)	63 (14.9%)
	50+	60 (16.3%)	7 (12.7%)	67 (15.8%)
Residence	Urban	244 (66.1%)	31 (56.4%)	275 (64.9%)
	Rural	125 (33.9%)	24 (43.6%)	149 (35.1%)
Marital status	Unmarried	36 (9.8%)	7 (12.7%)	43 (10.1%)
	Married	244 (66.1%)	33(60.0%)	277 (65.3%)
	Divorced	41 (11.1%)	8 (14.5%)	49 (11.6%)
	Widowed	48(13.0%)	7 (12.7%)	55 (13.0%)
Religion	Orthodox	238 (64.5%)	33 (60.0%)	271 (63.9%)
	Protestant	92 (24.9%)	17 (30.9%)	109 (25.7%)
	Catholic	4 (1.1%)	1 (1.8%)	5 (1.2%)
	Muslim	33 (8.9%)	4 (7.3%)	37 (8.7%)
	Others	2 (0.5%)	0 (0.0%)	2 (0.5%)
Occupational status	Farmer	73 (19.8%)	14 (25.5%)	87 (20.5%)
	Merchant	36 (9.8%)	7 (12.7%)	43 (10.1%)
	Government employee	39 (10.6%)	3 (5.5%)	42 (9.9%)
	House wife	128 (34.1%)	16 (29.1%)	144 (34.0%)
	Daily labor	66 (17.9%)	8 (14.5%)	74 (17.5%)
	Student	15 (4.1%)	4 (7.3%)	19 (4.5%)
	Others	12 (3.3%)	3 (5.5%)	15 (3.5%)
Facility ownership	Government	141 (38.2%)	9 (16.4%)	150 (35.4%)
	Non-government	228 (61.8%)	46 (83.6%)	274 (64.6%)
Facility type	Health center	141 (38.2%)	9 (16.4%)	150 (35.4%)
	General hospital	228 (61.8%)	46 (83.6%)	274 (64.6%)

B. Prevalence of Virological Non-Suppression and Clinical Characteristics

The mean (± SD) month on ART was 98.28 (± 44.57) months. Among 424 patients attending ART clinics, the majority 185 (43.6%) have baseline CD4 between 200-499 cells/μL, while 146 (34.4%) have baseline CD4 less than 200 cells/μL, 51 (12.0%) have greater than 500 cells/μL and for the rest 42 (9.9%) baseline CD4 were not done. Majority of

the patients 422 (99.5%) have WHO clinical stage I and stage II. Likewise, 422 (99.5%) have working functional status. Around 27 (6.4%) were undernourished and the rest have normal nutritional status. Regarding ART treatment, 355 (83.7%) were on first line regimen while 69 (16.3%) were on second line regimen. Majority of the patients, 342 (80.7%) were receiving Tenofovir disoproxil fumarate (TDF) + Lamivudine (3TC) + Dolutegravir (DTG) treatment regimen (Table II).

The prevalence of HIV viral load non-suppression was 55 (13.0%) with 95% CI (9.9-16.5) (Fig. 1). The reason for viral load testing was a routine viral load test in the majority of patients which was 371 (87.5%) and the rest 53 (12.5%) was targeted viral load testing (Table II).

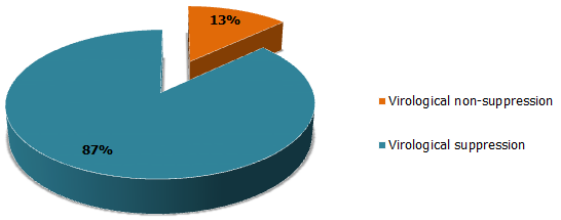

Fig. 1 Virological suppression among HIV-positive adult patients on ART in Woliso Town, Oromia, Ethiopia

C. Factors Associated with Virological Non-Suppression

The multivariate logistic regression analysis showed that ART treatment regimen and reason for virological test were significantly associated with virological non-suppression. After controlling the possible effect of confounding factors in the multivariate logistic regression, second-line ART treatment regimen (AOR = 8.98, 95% CI: 2.64, 30.58) and routine viral load testing (AOR = 0.01, 95% CI: 0.001, 0.02) were significantly associated with virological non-suppression (Table III).

IV. Discussion

This study was conducted to describe the prevalence of virological non-suppression and identify the factors associated with virological non-suppression among HIV infected adult patients attending ART clinics. This study revealed that HIV viral load non-suppression was 55 (13.0%) with 95% CI (9.9-16.5). After adjusting for controlling the possible effect of confounding factor variables in the multivariate logistic regression, second-line ART treatment regimen and routine viral load testing were significantly associated with virological non-suppression.

The virological suppression rate in this study was higher compared to the population-based survey in Kenya which showed that 61.2% virological non-suppression [7]. It was also higher than a study in East Shewa, Oromia which showed that 72% virological suppression and 76.8% in Cambodia [24], [26]. Similarly, the virological non-suppression of this study is lower than a study in Malawi, which was 39% [12] and significant number of patients in Northern Ethiopia, 26.39% had no viral suppression [12], [20]. On the other hand, the finding of this study was similar with a study in Uganda (11%) and Adigrat, North Ethiopia (12.47%) [13], [27]. Likewise, it was similar with a study in Gondar which was 13.2% [28] and Rwanda where 91% were virally suppressed [28], [29].

TABLE II
Clinical Characteristics of HIV-Positive Adult Patients on ART in Woliso Town, Oromia, Ethiopia (n = 424)

Variables		VLS Status		Total n (%)
		VL <1000 RNA copies/ml n (%)	VL ≥1000 RNA copies/ml n (%)	
Baseline CD5	<200 cells/µL	124 (33.6%)	22 (40.0%)	146 (34.4%)
	200 – 499 cells/µL	160 (43.4%)	25 (45.5%)	185 (43.6%)
	≥ 500 cells/µL	47 (12.7%)	4 (7.3%)	51 (12.0%)
	None	38 (10.3%)	4 (7.3%)	42 (9.9%)
WHO clinical stage	Stage I & II	368 (99.7%)	54 (98.2%)	422 (99.5%)
	Stage III & IV	1 (0.3%)	1 (1.8%)	2 (0.5%)
Functional status	Bed ridden	1 (0.3%)	0 (0%)	1 (0.2%)
	Ambulatory	1 (0.3%)	0 (0%)	1 (0.2%)
	Working	367 (99.5%)	55 (100%)	422 (99.5%)
Nutritional status	Under nourished	25 (6.8%)	2 (3.6%)	27 (6.4%)
	Normal	344 (93.2%)	53 (96.4%)	397 (93.6%)
ART Treatment	First line regimen	342 (92.7%)	13 (23.6%)	355 (83.7%)
	Second line regimen	27 (7.3%)	42 (76.4%)	69 (16.3%)
Current regimen	TDF+ 3TC+ DTG	329 (89.2%)	13 (23.6%)	342 (80.7%)
	TDF - 3TC - EFV	7 (1.9%)	0 (0.0%)	7 (1.7%)
	Other first line	6 (1.6%)	0 (0.0%)	6 (1.4%)
	AZT +3TC +LPV/r	1 (0.3%)	1 (1.8%)	2 (0.5%)
	AZT+3TC +ATV/r	10 (2.7%)	15 (27.3%)	25 (5.9%)
	TDF + 3TC+-LPV/r	0 (0.0%)	1 (1.8%)	1 (0.2%)
	TDF + 3TC + ATV/r	15 (4.1%)	23 (41.8%)	38 (9.0%)
	Other second line	1 (0.3%)	2 (3.6%)	3 (0.7%)
Duration on ART	6-11 months	2 (0.5%)	0 (0.0%)	2 (0.5%)
	1-5 years	102 (27.6%)	12 (21.8%)	114 (26.9%)
	6-9 years	143 (38.8%)	21 (38.2%)	164 (38.7%)
	≥10 years	122 (33.1%)	22 (40.0%)	144 (34.0%)
Adherence to ART	Poor	13 (3.5%)	4 (7.3%)	17 (4.0%)
	Fair	2 (0.5%)	0 (0.0%)	2 (0.5%)
	Good	354 (95.9%)	51 (92.7%)	405 (95.5%)
Reason for virological testing	Routine viral load	364 (98.6%)	7 (12.7%)	371 (87.5%)
	Targeted viral load	5 (1.4%)	48 (87.3%)	53 (12.5%)
History of co-morbidity	No	361 (97.8%)	54 (98.2%)	415 (97.9%)
	Yes	8 (2.2%)	1 (1.8%)	9 (2.1%)

This study revealed that the likelihood of developing viral non-suppression for patients on second-line treatment regimen was 8.98 times (AOR = 8.98, 95% CI: 2.64, 30.58) more likely when compared with patients on a first-line treatment regimen. This evidence is similar with a systemic review and meta-analysis in sub-Saharan Africa, which showed the pooled second-line HIV treatment failure rate was 15.0 per 100 PYs (95% CI: 13.0-18.0) [10]. More than half of people in low- and middle-income countries may not maintain viral suppression on second-line ART [30]. It is also consistent with two South African studies [31], [32]. This may be due to the fact that, as shown in this study, the majority (89.2%) of

patients on first-line regimen were receiving a DTG-based regimen for first-line therapy during the study period and therefore, this could be considered as the reason for the deviation of virological non-suppression in second-line therapy. However, there is other inconsistent evidence that showed good virological outcomes can be achieved with protease inhibitors (PI)-based second-line ART in both adult and pediatric patients in rural South Africa [9]. Another study in Kenya showed that a second-line ART regimen has shown no significant association with virological non-suppression [33]. Similarly in Uganda, second-line ART regimens were protective against viral non-suppression [13]. Even though this finding revealed the emerging challenges of second-line treatment in achieving viral suppression, this variation may be due to the reason that there were other different client-related and program-related factors that affect virological suppression [10], [13], [33], [34]. Virological non-suppression associated with second-line regimen ART treatment may compromise future second-line and third-line regimens in the absence of routine HIV drug resistance testing [35]. It also has critical implications in resource-limited settings; including sub-Saharan Africa [10]. In patients on second-line treatment regimen with virological non-suppression, particular attention should be paid when considering the next treatment option [34]. Therefore, monitoring HIV viral load suppression status in people living with HIV is the core to maintain effective individual ART as well as monitoring progress toward achieving global 95% targets for viral suppression [4].

TABLE III
FACTORS ASSOCIATED WITH VIRAL NON-SUPPRESSION AMONG HIV-POSITIVE ADULT PATIENTS ON ART IN WOLISO TOWN, OROMIA, ETHIOPIA (N = 424)

Variables		VLS status		Total n (%)	COR (95 % CI)	AOR (95 % CI)
		VL <1000 RNA copies/ml n (%)	VL ≥1000 RNA copies/ml n (%)			
Residence	Urban	244 (66.1%)	31 (56.4%)	275 (64.9%)	1	1
	Rural	125 (33.9%)	24 (43.6%)	149 (35.1%)	1.51 (0.85, 2.69)	2.14 (0.62, 7.44)
Facility type	Health center	141 (38.2%)	9 (16.4%)	150 (35.4%)	1	1
	General hospital	228 (61.8%)	46 (83.6%)	274 (64.6%)	3.16 (1.50, 6.66)**	1.77 (0.34, 9.27)
ART Treatment	First line regimen	342 (92.7%)	13 (23.6%)	355 (83.7%)	1	1
	Second line regimen	27 (7.3%)	42 (76.4%)	69 (16.3%)	40.92 (19.62, 85.36)***	8.98 (2.64, 30.58)***
Current regimen	TDF+ 3TC+ DTG	329 (89.2%)	13 (23.6%)	342 (80.7%)	0.02 (0.002, 0.23)**	
	TDF - 3TC - EFV	7 (1.9%)	0 (0.0%)	7 (1.7%)		
	Other first line	6 (1.6%)	0 (0.0%)	6 (1.4%)		
	AZT +3TC +LPV/r	1 (0.3%)	1 (1.8%)	2 (0.5%)	0.50 (0.01, 19.56)	0.05 (0.0, 22.34)
	AZT+3TC +ATV/r	10 (2.7%)	15 (27.3%)	25 (5.9%)	0.75 (0.06, 9.42)	0.495 (0.002, 130.12)
	TDF + 3TC+-LPV/r	0 (0.0%)	1 (1.8%)	1 (0.2%)		
	TDF + 3TC + ATV/r	15 (4.1%)	23 (41.8%)	38 (9.0%)	0.77 (0.06, 9.22)	3.01 (0.013, 702.38)
	Other second line	1 (0.3%)	2 (3.6%)	3 (0.7%)	1	1
Reason for virological testing	Routine viral load	364 (98.6%)	7 (12.7%)	371 (87.5%)	0.002 (0.001, 0.01)***	0.01 (0.001, 0.02)***
	Targeted viral load	5 (1.4%)	48 (87.3%)	53 (12.5%)	1	1

Notes: * statistically significant (P-value ≤0.05); ** strong statistical significance (P-value ≤0.01); very strong statistical significance (P-value 0.001).

This study also revealed that the likelihood of developing viral non-suppression was 99% less likely among routine viral load testing (AOR = 0.01, 95% CI: 0.001, 0.02) when compared with targeted viral load testing. This finding was similar with study in Northern Ethiopia, which showed that virological non-suppression was significantly associated with reason for virological test [20]. Similarly, virological non-suppression was significantly associated with targeted viral load testing in suspected virological treatment failures in Uganda [13], Malawi [36], Vietnam [37], [38], and India [39]. This also indicates the need to strengthen the platform of virological treatment failure identification through clinical, immunological and virological monitoring of patients during routine follow up visits. Therefore, routine viral load testing should be feasible and accessible to all clients in need of virological testing.

V. LIMITATIONS OF THE STUDY

The study findings should be interpreted within the following limitations. The analysis was based on a single point of test and cannot establish causality or the timing of virological non-suppression. The findings of this study cannot be generalizable as it utilizes data from patient medical records which may lack other important factor variables for virological suppression status due to the nature of secondary data.

VI. RECOMMENDATION

This study gives evidence of factors associated with virological non-suppression among HIV-positive adult patients on ART in Woliso Town, Oromia, Ethiopia. It further describes the prevalence of virological non-suppression. Also, it suggests that there is an urgent need to improve virological suppression that constitutes to end HIV by such interventions:

1. Decentralization of third-line HIV treatment regimens to all health facilities in need to be accessible by eligible patients.
2. Intensive adherence counselling and routine patient monitoring should be provided to achieve durable viral load suppression.

3. Further assessment of the effectiveness antiretroviral drug is needed to control the HIV pandemic.

Abbreviations

- ATV/r: Atazanavir/Ritonavir
- AZT: Azidothymidine
- COR: Crude Odds Ratio
- EFV: Efavirenz
- LPV/r: Lopinavir/Ritonavir
- TDF: Tenofovir disoproxil fumarate
- VL: Viral Load

Authors Contributions

T.H. conceived and designed the study; adopted data collection checklist and acquisition of data; cleaned the data set, analyzed the data, and interpreted findings; drafted the manuscript; S.A. supervised over the data collection and trained the data collectors; B.H. critically reviewed the final manuscript. All authors have read and approved the article.

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References

[1] Federal HIV/AIDS Prevention and Control Office, "HIV Prevention in Ethiopia National Road Map 2018 - 2020." Nov. 2018.

[2] Federal Ministry of Health Ethiopia (FMOH), "National Comprehensive Care and Treatment guideline for Implementation 2018." Aug. 2018.

[3] PEPFAR, "PEPFAR 2020 Country Operational Plan Guidance for all PEPFAR Countries" US Government, Nov. 25, 2019, (Online). Available: https://www.pepfar.net.

[4] P. K. Drain *et al.*, "Point-of-Care HIV Viral Load Testing: an Essential Tool for a Sustainable Global HIV/AIDS Response," *Clin. Microbiol. Rev.*, vol. 32, no. 3, 19 2019, doi: 10.1128/CMR.00097-18.

[5] J. E. Haberer *et al.*, "ART adherence and viral suppression are high among most non-pregnant individuals with early-stage, asymptomatic HIV infection: an observational study from Uganda and South Africa," *J Int AIDS Soc*, vol. 22, no. 2, p. e25232, 2019, doi: 10.1002/jia2.25232.

[6] L. S. Park *et al.*, "Association of Viral Suppression with Lower AIDS-Defining and Non-AIDS-Defining Cancer Incidence in HIV-Infected Veterans: A Prospective Cohort Study," *Ann. Intern. Med.*, vol. 169, no. 2, pp. 87–96, 17 2018, doi: 10.7326/M16-2094.

[7] P. Cherutich *et al.*, "Detectable HIV Viral Load in Kenya: Data from a Population-Based Survey," *PLoS ONE*, vol. 11, no. 5, p. e0154318, 2016, doi: 10.1371/journal.pone.0154318.

[8] C. Shoko and D. Chikobvu, "Determinants of viral load rebound on HIV/AIDS patients receiving antiretroviral therapy: results from South Africa," *Theor Biol Med Model*, vol. 15, no. 1, p. 10, 16 2018, doi: 10.1186/s12976-018-0082-0.

[9] A. F. Schoffelen, A. M. J. Wensing, H. A. Tempelman, S. P. M. Geelen, A. I. M. Hoepelman, and R. E. Barth, "Sustained Virological Response on Second-Line Antiretroviral Therapy following Virological Failure in HIV-Infected Patients in Rural South Africa," *PLoS One*, vol. 8, no. 3, Mar. 2013, doi: 10.1371/journal.pone.0058526.

[10] D. Edessa, M. Sisay, and F. Asefa, "Second-line HIV treatment failure in sub-Saharan Africa: A systematic review and meta-analysis," *PLoS ONE*, vol. 14, no. 7, p. e0220159, 2019, doi: 10.1371/journal.pone.0220159.

[11] V. Q. Dat *et al.*, "Viral load suppression and acquired HIV drug resistance in adults receiving antiretroviral therapy in Viet Nam: results from a nationally representative survey," *Western Pac Surveill Response J*, vol. 9, no. 3, pp. 16–24, Sep. 2018, doi: 10.5365/wpsar.2018.9.1.008.

[12] E. Umar, J. A. Levy, R. C. Bailey, G. Donenberg, R. C. Hershow, and M. E. Mackesy-Amiti, "Virological Non-suppression and Its Correlates Among Adolescents and Young People Living with HIV in Southern Malawi," *AIDS Behav*, vol. 23, no. 2, pp. 513–522, Feb. 2019, doi: 10.1007/s10461-018-2255-6.

[13] L. Bulage *et al.*, "Factors Associated with Virological Non-suppression among HIV-Positive Patients on Antiretroviral Therapy in Uganda, August 2014-July 2015," *BMC Infect. Dis.*, vol. 17, no. 1, p. 326, 03 2017, doi: 10.1186/s12879-017-2428-3.

[14] G. Namale *et al.*, "Sustained virological response and drug resistance among female sex workers living with HIV on antiretroviral therapy in Kampala, Uganda: a cross-sectional study," *Sex Transm Infect*, vol. 95, no. 6, pp. 405–411, Sep. 2019, doi: 10.1136/sextrans-2018-053854.

[15] E. Kuhn *et al.*, "Viral load strategy: impact on risk behaviour and serocommunication of men who have sex with men in specialized care," *J Eur Acad Dermatol Venereol*, vol. 30, no. 9, pp. 1561–1566, Sep. 2016, doi: 10.1111/jdv.13672.

[16] N. Aziz *et al.*, "Time to viral load suppression in antiretroviral-naive and -experienced HIV-infected pregnant women on highly active antiretroviral therapy: implications for pregnant women presenting late in gestation," *BJOG*, vol. 120, no. 12, pp. 1534–1547, Nov. 2013, doi: 10.1111/1471-0528.12226.

[17] D. M. Coviello *et al.*, "Prevalence of HIV Viral Load Suppression Among Psychiatric Inpatients with Comorbid Substance Use Disorders," *Community Ment Health J*, vol. 54, no. 8, pp. 1146–1153, 2018, doi: 10.1007/s10597-018-0284-2.

[18] M. Daskalopoulou *et al.*, "Non-Disclosure of HIV Status and Associations with Psychological Factors, ART Non-Adherence, and Viral Load Non-Suppression Among People Living with HIV in the UK," *AIDS Behav*, vol. 21, no. 1, pp. 184–195, Jan. 2017, doi: 10.1007/s10461-016-1541-4.

[19] T. Nsubuga-Nyombi *et al.*, "Multivariate analysis of covariates of adherence among HIV-positive mothers with low viral suppression," *AIDS Res Ther*, vol. 15, no. 1, p. 9, 31 2018, doi: 10.1186/s12981-018-0197-8.

[20] A. A. Desta *et al.*, "HIV virological non-suppression and factors associated with non-suppression among adolescents and adults on antiretroviral therapy in northern Ethiopia: a retrospective study," *BMC Infectious Diseases*, vol. 20, no. 1, p. 4, Jan. 2020, doi: 10.1186/s12879-019-4732-6.

[21] A. Mulu, U. G. Liebert, and M. Maier, "Virological efficacy and immunological recovery among Ethiopian HIV-1 infected adults and children," *BMC Infect. Dis.*, vol. 14, p. 28, Jan. 2014, doi: 10.1186/1471-2334-14-28.

[22] C. D. Agegnehu, M. W. Merid, and M. K. Yenit, "Incidence and predictors of virological failure among adult HIV patients on first-line antiretroviral therapy in Amhara regional referral hospitals; Ethiopia: a retrospective follow-up study," *BMC Infect Dis*, vol. 20, Jul. 2020, doi: 10.1186/s12879-020-05177-2.

[23] H. Negash *et al.*, "The effect of tuberculosis on immune reconstitution among HIV patients on highly active antiretroviral therapy in Adigrat general hospital, eastern Tigrai, Ethiopia; 2019: a retrospective follow up study," *BMC Immunol.*, vol. 20, no. 1, p. 45, 05 2019, doi: 10.1186/s12865-019-0327-7.

[24] J. H. Ali and T. G. Yirtaw, "Time to viral load suppression and its associated factors in cohort of patients taking antiretroviral treatment in East Shewa zone, Oromiya, Ethiopia, 2018," *BMC Infect. Dis.*, vol. 19, no. 1, p. 1084, Dec. 2019, doi: 10.1186/s12879-019-4702-z.

[25] A. T. Tsegaye, M. Wubshet, T. Awoke, and K. Addis Alene, "Predictors of treatment failure on second-line antiretroviral therapy among adults in northwest Ethiopia: a multicentre retrospective follow-up study," *BMJ Open*, vol. 6, no. 12, p. e012537, 08 2016, doi: 10.1136/bmjopen-2016-012537.

[26] K. Chhim *et al.*, "Factors associated with viral non-suppression among adolescents living with HIV in Cambodia: a cross-sectional study," *AIDS Res Ther*, vol. 15, no. 1, p. 20, 17 2018, doi: 10.1186/s12981-018-0205-z.

[27] H. Negash *et al.*, "Increased Virological Failure and Determinants Among HIV Patients on Highly Active Retroviral Therapy in Adigrat General Hospital, Northern Ethiopia, 2019: Hospital-Based Cross-Sectional Study," *Infect Drug Resist*, vol. 13, pp. 1863–1872, Jun. 2020, doi: 10.2147/IDR.S251619.

[28] G. Ayele, B. Tessema, A. Amsalu, G. Ferede, and G. Yismaw,

"Prevalence and associated factors of treatment failure among HIV/AIDS patients on HAART attending University of Gondar Referral Hospital Northwest Ethiopia," *BMC Immunol*, vol. 19, no. 1, p. 37, Dec. 2018, doi: 10.1186/s12865-018-0278-4.

[29] J. Ross *et al.*, "High levels of viral load monitoring and viral suppression under Treat All in Rwanda - a cross-sectional study," *J Int AIDS Soc*, vol. 23, no. 6, p. e25543, Jun. 2020, doi: 10.1002/jia2.25543.

[30] "Failure of second-line ART is common in resource-limited countries, but modern third-line regimens work well," *aidsmap.com*. https://www.aidsmap.com/news/mar-2018/failure-second-line-art-common-resource-limited-countries-modern-third-line-regimens (accessed Aug. 25, 2020).

[31] Z. El-Khatib *et al.*, "Viremia and drug resistance among HIV-1 patients on antiretroviral treatment: a cross-sectional study in Soweto, South Africa," *AIDS*, vol. 24, no. 11, pp. 1679–1687, Jul. 2010, doi: 10.1097/QAD.0b013e32833a097b.

[32] G. U. van Zyl *et al.*, "Low lopinavir plasma or hair concentrations explain second-line protease inhibitor failures in a resource-limited setting," Apr. 2011, doi: 10.1097/QAI.0b013e31820dc0cc.

[33] R. K. A. Sang and F. O. Miruka, "Factors Associated with Virologic Failure Amongst Adults on Antiretroviral Therapy in Nyanza Region, Kenya.," *IOSR*, vol. 15, no. 07, pp. 108–121, Jul. 2016, doi: 10.9790/0853-15076108121.

[34] M. Sylla *et al.*, "Second-line antiretroviral therapy failure and characterization of HIV-1 drug resistance patterns in children in Mali," *Arch Pediatr*, vol. 26, no. 5, pp. 254–258, Jul. 2019, doi: 10.1016/j.arcped.2019.06.002.

[35] S. Miti *et al.*, "Prevalence and characteristics of HIV drug resistance among antiretroviral treatment (ART) experienced adolescents and young adults living with HIV in Ndola, Zambia," *PLOS ONE*, vol. 15, no. 8, p. e0236156, Aug. 2020, doi: 10.1371/journal.pone.0236156.

[36] R. G. Mungwira *et al.*, "A targeted approach for routine viral load monitoring in Malawian adults on antiretroviral therapy," *Trop. Med. Int. Health*, vol. 23, no. 5, pp. 526–532, 2018, doi: 10.1111/tmi.13047.

[37] S. Rangarajan *et al.*, "Factors associated with HIV viral load suppression on antiretroviral therapy in Vietnam," *J Virus Erad*, vol. 2, no. 2, pp. 94–101, Apr. 2016.

[38] T. M. Pollack *et al.*, "Routine versus Targeted Viral Load Strategy among Patients Starting Antiretroviral in Hanoi, Vietnam," *J Int AIDS Soc*, vol. 22, no. 3, p. e25258, 2019, doi: 10.1002/jia2.25258.

[39] C. Laxmeshwar *et al.*, "Routine viral load monitoring and enhanced adherence counselling at a public ART centre in Mumbai, India," *PLoS ONE*, vol. 15, no. 5, p. e0232576, 2020, doi: 10.1371/journal.pone.0232576.