

Incidence of High Viral Load and Associated Factors Among Adults Receiving Antiretroviral Therapy Under the HIV Test-and-Treat Program in West Hararghe Zone, Eastern Ethiopia: A Retrospective Cohort Study

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Abstract

Background

Universal HIV test-and-treat policies aim to achieve rapid antiretroviral therapy (ART) initiation and sustained virological suppression. However, high viral load remains an important challenge in routine HIV care. Evidence on its incidence and predictors among adults receiving ART in eastern Ethiopia is limited.

Objective

To determine the incidence of high viral load and identify associated factors among adults receiving ART under the HIV test-and-treat program in selected public health facilities of West Hararghe Zone, eastern Ethiopia.

Methods

A facility-based retrospective cohort study was conducted using records of adults who initiated ART between January 2018 and December 2022. A total of 517 eligible records were analyzed. Data were extracted using a structured checklist and analyzed in STATA version 15. Time-to-event analysis and Cox proportional hazards regression were used. Adjusted hazard ratios (AHRs) with 95% confidence intervals (CIs) were reported.

Results

Among 517 adults receiving ART, 68 (13.15%; 95% CI: 10.50–16.36) developed high viral load. The median time to development of high viral load was 18 months (95% CI: 14.5–22.7). Rural residence (AHR = 1.92; 95% CI: 1.05–3.52) and opportunistic infection (AHR = 3.38; 95% CI: 1.61–7.15) were associated with an increased hazard of high viral load.

Conclusion

High viral load occurred in a substantial proportion of adults receiving ART under the test-and-treat program. Patients living in rural areas and those with opportunistic infections had a higher hazard of developing high viral load. Strengthening adherence support, early detection and management of opportunistic infections, and differentiated follow-up for higher-risk patients may improve virological outcomes.

Background

The World Health Organization estimates that there over 34 million people infected with the human immunodeficiency virus (HIV)-1 globally, with the majority of those infected living in the developing world and 2.9 million new infections in 2010 (UNAIDS, 2010). The development and dissemination of antiretroviral therapy has resulted in significant reductions in mortality associated with HIV infection and its complications worldwide. Despite international programs to produce and distribute low-cost ARVs among developing nations, only 8 million HIV-infected people have access to ART in these countries as of 2011, with the goal to start another 7 million on therapy by 2015 (UNAIDS, 2010). In 2016 globally there were 36.7 million people living with HIV, 1.8 million new HIV infections, and 1 million AIDS related deaths (UNAIDS, 2017). Sub-Saharan Africa (SSA) contributed 76% of the total HIV-infected people, 76% of the total new HIV infections, and 75% of the total HIV/AIDS deaths in 2015(Wang et al., 2016).

It is characterized by a low-intensity, mixed epidemic and self-sustaining transmission with a prevalence of 1.1%. In 2016, there were 720,000 people living with HIV and 27,104 newly diagnosis cases (Wang et al., 2016). But only 67% of expected PLWH know their status and 59% of them were enrolled in highly active antiretroviral therapy (HAART) program, while significant proportion people living with HIV were died (UNAIDS, 2017, EPHI, 2017, Wang et al., 2016)

The gravity of the situation was further emphasized by the fact that, by the end of 2018, the number of infected individuals had risen to a staggering 74.9 million, with 32 million lives lost due to AIDS-related illnesses on a global scale (UNAIDS, 2020a).

The trend, however, took a notable turn by 2019, as reported by the United Nations program on AIDS (UNAIDS). The data suggested that the number of people living with HIV had reached 38 million, reflecting an increase from the previous year. Within this population, 1.7 million individuals were newly infected, underlining the persistent challenges in prevention efforts. Tragically, thousands had succumbed to the disease, highlighting the ongoing impact of HIV/AIDS on global public health (UNAIDS, 2020b). The world has been battling with this epidemic for almost 4 decades, sub-Saharan Africa being the most affected region with 46% of the world's HIV burden. In South Africa, the HIV prevalence has remained steady during the past decade, contributing approximately 19% of the total burden of HIV globally in 2015. Currently the HIV prevalence rate is estimated at 20.4% in South Africa (UNAIDS, 2019, UNAIDS, 2020, WHO, 2016).

In Ethiopia, an estimated 738,976 people are currently living with HIV and all of them require (ART). Various programs have been undertaken to increase the health quality of HIV-positive patients, the quality of life, and to prolong the period of HIV-infection/AIDS-diagnosis to death; however, around 11,000 people in Ethiopia are dying from HIV-related disease (EDHS, 2016). With free HIV testing and ART service, there should be no HIV-related death; however, death from HIV related causes in the world, especially in developing countries such as Ethiopia is still being reported. Ethiopia has adopted the test and treat recommendation since February 2017 and since then all HIV-positive clients are eligible to start ART right away (Tadesse et al., 2014). Early diagnosis is key for tracing of HIV-positive people and leads to early initiation of ART, and hence might significantly reduce the rate of HIV-related mortality. The test

and treat strategy is aimed to markedly decrease mortality related to HIV/AIDS (WHO, 2016). Ethiopia has changed the eligibility criteria of HIV-positive people for ART utilization. Recently Ethiopia adopted the WHO test and treat strategy and started the implementation on pilot bases in some health facilities then expanded to all health facilities in the country (Walensky et al., 2010).

Ethiopia started implementing the “test and treat” policy in 2017 (FMoH, 2017). Same-day ART initiation may be a key approach in reaching the 2020 Joint United Nations Program on HIV/AIDS goal of 90% of all people living with HIV knowing their status, 90% of those diagnosed receiving sustained ART, and 90% of those receiving ART achieving viral suppression. It may also be important for achieving the suggested fourth “90%” goal: improving health-related quality-of-life in PLHIV (Boyd et al., 2019)

Statement of problems

Human immunodeficiency virus (HIV) infection remains the leading cause of morbidity and mortality throughout the world. The World Health Organization (WHO) recommends the “universal test and treat” (UTT) program as strategy for HIV elimination in place of the previous “differed treatment” CD4 based and WHO clinical staging approaches program (MacCarthy et al., 2015). UTT is a program which commends all population at risk is screened for HIV infection and those diagnosed HIV positive receive early treatment regardless of their CD4 count and WHO clinical stage. Many countries including Ethiopia had adopted the ‘test and treat’ program (WHO, 2015). Global prevalence among adults (the percent of people ages 15–49 who are infected) has leveled since 2001 and was 0.7% in 2022. There were 39 million people living with HIV in 2022, up from 31.5 million in 2010, the result of continuing new infections and people living longer with HIV. Of the people living with HIV in 2022, 37.5 million were adults and 1.5 million were children under age 15. (UNAIDS, 2023). Ethiopia is one of HIV hard hit countries with a prevalence of 1.1% (EPHI, 2017).

Although, the health care systems have accepted the public health benefit of universal test and treat strategy for the prevention of new transmission, evidences on its impact on clinical outcome and patient survival are limited (WHO, 2016). Although, WHO recommends the universal test and treat program, about 11% of low- and middle-income countries (LMICs) do not implemented it yet (WHO, 2019). As a result of clinical, public health and economic concerns different countries have been recommended ART initiation at different stages of the disease or at different levels of CD4 count (EACS, 2013).

The incidence of LTFU ranges from 7.1 per 100 persons per year of observation in India (Alvarez-Uria et al., 2013), 10.3 in South Africa (Mberi et al., 2015), 26.3 in Malawi (Webb, 2018), and 7.5 in Uganda, respectively. (Kiwanuka et al., 2020)

Moreover, studies conducted in Ethiopia before UTT have shown that both the proportion and incidence of LTFU greatly vary across regions and health institutions. For instance, in Debre Markos, Gondar, Pawi, Hadiya, and Jigigia (Eastern Ethiopia), it reaches 10.5 per 100 PYO, 11.6 per 100 PYO, 11.9 per 100 PYO, and 26.6 per 100 PY, respectively (Teshale et al., 2020) However, few studies conducted at some LMICs

such as South Africa (Chauke et al., 2020), Nigeria (Stafford et al., 2019), Zimbabwe (Makurumidze et al., 2020), and Uganda (Kiwanuka et al., 2020) revealed that rapid initiation of ART significantly increases the incidence of LTFU. Approximately 34 and 33% of patients in Nigeria and South Africa who initiated ART in this era, respectively, were lost from their routine follow up within 12 months in Nigeria and 24 months in South Africa (Joseph Davey et al., 2020).

Late diagnosis is associated with: increased HIV related morbidity and mortality, shorter survival, poor response to treatment, increased healthcare costs and increased rates of HIV transmission. If a person is diagnosed and treated for HIV early in the course of infection before severe impairment of the immune system has occurred, life-expectancy may approach that of the general population (van der Kop et al., 2016). In Ethiopia, evidences on the Incidence of High Viral Load of test and treat ART users and predictors are limited. Therefore, the aim of this study was to determine the Incidence of High Viral Load of test and treat program.

Objectives

General objective

To assess incidence of High viral load and Associated factors among adult ART service users under HIV test-and-treat program in West Hararghe Public Health Facilities eastern Ethiopia from April, 20-May 20/2023

Specific Objectives

- To assess high viral load among adult antiretroviral therapy service users under HIV test-and-treat program at Public Health Facilities in West Hararghe.
- To identify associated factors of high viral load among adult ART service users under HIV test-and-treat program at Public Health Facilities in West Hararghe.

Methods

Study design and setting

The retrospective single arm cohort study was conducted in public health facility in west Hararghae zone, Oromia regional state, Eastern Ethiopia, from April, 20-May 20/2023. West Hararghae zone is found at 333km away from capital city Addis Ababa. It has 15 districts and 5 administrative towns. The Zone boundaries with Somali and Afar Regional State in the North, Arsi and East Shoa zone in West, East Hararghae zone in the East and Bale zone in the South. According to the population projection of 2022 the total population of West Hararghae zone in 2022 was estimated to be 2,725, 156 (ESS, 2022). Currently, the Zone has 493 kebeles, 482 health posts, 85 health centers and 7 hospitals with 945 health extension workers and 3225 other health workers and total of 4170 governmental health workers.

Among those health facility test and treat program is being implemented in 16(sixteen) health center and 5 hospitals for 3153 HIV patients.

Eligibility Criteria

Inclusion Criteria: All adults aged 15 years and older, diagnosed as HIV-positive after the launch of the "Test and Treat" initiative at selected health facilities between January 2018 and December 2022, were included in the study. **Exclusion Criteria**

Exclusion criteria: Records with more than 20% missing data, such as missing information on the date of HIV diagnosis, CD4 count, viral load count, date of outcome development, and date of ART initiation, were excluded from the study.

Sample size sampling procedure

The sample size is calculated using single population proportion formula considering 95%CI (confidence interval), $Z = 1.96$, $P =$ proportion of low CD4 count among ART users in test and treat program ($P = 0.5$) as there is no previous study, $d =$ Standard Error or Precision = 0.05. The response rate, design effect and correction formula were considered, and the final calculated sample size was 525. The sample was selected by using multi stage sampling technique. The primary sampling units was all ART service public health facility stratified in to hospitals and health centers which are found in the west hararghae zones. From total of 21 health facility (5 hospitals, 16 health centers). From those by using simple random sampling technique select 5-health facilities, 2 hospitals, 3 health centers. As such five health facility (Chiro hospital, Gelemso hospital, Bedesa health center, Hirna health center, and Micheta health center) was selected by lottery method sample size was proportional allocated to sample of selected health facilities. A simple random sampling method was employed until the required sample size of 525 was reached across all health facilities. Study subjects from each health facility were then identified through secondary data collection from registration books, intake cards, and follow-up documents (Fig. 1)

Data collection methods

Data were collected using a structured abstract checklist adopted from "program review of Test and treat ART program and identified variables from relevant literature and similar studies" (Girum, 2020). The structured abstract checklist was developed in English with five sections. Including Background characteristics, HIV Screening, Initiation of ART and Functional status and HIV WHO stages, TB screening, opportunistic infection and treatment, adherence for TPT and side effect and assessment of pain and management, nutrition screening, pregnancy status and PMTCT and blood test for CD4, viral load, ARV drugs, regimen, dispensing dose, DSD and related totally it have 60 questions. The sources of data for this study were Pre-ART register, the ART register and the patients' ART follow up, intake card and medical charts. In those registers and follow up charts, clients' socio demographic, clinical and laboratory information, treatments being provided, the follow up status of each client were recorded.

Data was collected from client charts using a structured checklist for records review developed from the registers, intake card and follow up charts. Then, data were collected from randomly selected health facilities by four trained data collectors. Each data collector collected data from 20–30 folder (record) daily. Two supervisors were assigned to oversee the supervision and collected data abstract checklists on a regular basis ensuring consistency and completeness. All data collectors and supervisors selected based on experience on ART program handling and at least a diploma and BSC degree holders and above, respectively. Principal investigator and supervisors followed the overall activities every day to make sure the completeness of the questionnaires and also, they are responsible for overall data collection process.

Measurement of outcome and exposure

Viral load refers to the amount of virus in an infected person's blood. This is expressed as the number of viral particles in each milliliter of blood. Higher viral load can have different implications for different viruses but typically means the infection is progressing (CDC).

Test-and-treat: - is an intervention strategy in which the population at risk is screened for HIV infection and diagnosed HIV infected individuals receive early treatment, aiming to eliminate HIV as it reduces the rate of spreading the virus to other people (CDC, 2017).

Viral suppression

- defined as having less than 200 copies of HIV per milliliter of blood. HIV medicine can even make the viral load so low that a test can't detect it. This is called an **undetectable viral load**.

Data quality control

Detail training regarding the objectives of the study and data collection process was given to the data collectors and supervisors for two days. Pre-testing was conducted on 5% of the sample in those ART site not included in the actual study area. Data collectors was closely supervised before and during the data collection process by the supervisor. The principal investigator was supervising the correct implementation of the procedure and check the completeness and logical consistency after data collection. To keep completeness and consistency, two individuals did double data entry to minimize errors. Then Evaluate the acceptability, applicability, and reliability of the procedures and tools in the questionnaires. Finally, after data collection, each questionnaire was given a unique code by the principal investigator.

Data analysis

The data analysis was after data collection, the questionnaire was checked for completeness and data entry was made using Epi Data version 3.1 and the entered data was exported to STATA version 15.0 software. Descriptive statistics and categorical data analysis. We used a log-rank test to select potential candidate predictors. Predictors of Incidence of High Viral Load among adult antiretroviral therapy

service user were identified using a multivariable Cox proportional hazards model. adjusted hazard ratios (AHR), 95% CI and P-values were calculated to assess the association of various determinants with the risk of Incidence of High Viral Load of antiretroviral therapy user among adult. A final Cox proportional hazard model was fitted by including all potential predictors with a significance level < 0.25 in the log-rank test. A P-value less than 0.05 was considered statistically significant. We checked all the possible interactions and found no statistically significant interaction terms.

Proportionality was checked by including time-dependent covariates in the model, and the interaction between covariates and time was not statistically significant. This implies that the effect of a risk factor is constant over time and therefore, proportionality assumption of the Cox hazards model was fulfilled. The ratio of the hazard function ($h(t)$) to the baseline hazard function ($h_0(t)$) at any time is expected to be constant. The Cox proportional hazards model assumes that the predictors have a multiplicative effect on the hazard and that this effect is constant over time.

Results

Socio demographic characteristics

The study was carried out in five selected hospital and health centers in West Hararghe zone with a sample of 525 adult clients who began ART between January 2018 and December 2022. Out of 525 randomly selected Adult ART users, a total of 517 records in the study (a response rate of 98.5%) were ART user, while 91(17.60%), 98(18.96%) 96(18.57%) 92(17.79) and 140(27.08%) were started in 2018, 2019, 2020, 2021 and 2022 respectively. From the 517 participants, 302 (58.41%) were females and 215 (41.59%) were males. Regarding their religion, 213(41.19),174(33.65),112(21.66) and 18(3.40) of the participants were Orthodox Christians, Muslin, Protestant, Catholic and other respectively. (See Table 1)

Of the study subjects 302 female participant 58(19.20%), 89(29.47%), of them were had no formal education and Graduated at the time of initiation of their ART treatment respectively and from 217 participants of male 54(25.11%) and 104(48.37%) of them were had primary school and Graduated at the time of initiation of their ART treatment respectively. Almost 46.03% of the patients were unemployed at the time of initiation of ART and 65.76% of the patients were enrolled from urban districts. From study subject 61.50% of them were married and 14.50% single(unmarried). (Table1)

HIV Screening, Initiation of ART and Functional status and HIV WHO stages.

Out of 517 ART users 438(84.71%) were early initiate and 79(15.29%) are were late initiate. From 517 participant year of high viral-load events and ART started in 2022 134(25.9) and 140(27.07) respectively. The client set HIV prevention methods 380(73.50) are Assessed for STI and 123(23.79) of them discussed and agreed to practice safer sex. The status of their functional 485(93.81%), 26(5.02%) and 6(1.16%) of them were had no working, Ambulatory and bedridden at the time of data collection respectively. Regarding HIV clinical stage of 338(65.37%) were in WHO first stage and 179(34.62%) above second stage patients were at the time of data collection. (Table 2).

Opportunistic Infection, Adherence for TPT and Assessment of pain.

Out of records 461(89.16) used TB prophylaxis. From 517 patients, 186(35.97%) had opportunistic infections at the time of treatment initiation and out of opportunistic infections herpes zoster 27(14.52%), respiratory disease 78(41.94%), oral disease is 37(19.89%) and Diarrheal disease 44(23.65%) are at the time of initiation of their ART treatment. The Assessment of pain from 517 records 369(71.4), 44(8.5), 88(17.02) and 16(3.04) of them were had No-pain, mild pain, moderate pain and severe pain respectively. (Table 3)

Nutrition Screening, Pregnancy status, PMTCT and Body mass index.

From total of 517 randomly selected ART user people, 229 (44.29%) were use family planning and those users had choice of method 175(76.42) had use Injectable and 28(12.23) had condom user. From 517 records 440(85.3%) had normal body mass index, 64(12.4%) of them are overweight, 8(1.4%) of them are under weight and 5(0.97%) are obesity. (Table 4).

Blood test for CD4, VL ARV drugs, Regimen, Dispensing Dose and DSD.

From 517 368(71.4) has normal CD4 and 148(28.6) of then low CD4. Three hundred seventy (71.6%) patients had good, 124(23.99%) fair and 23(4.45%) poor cotrimoxazole adherences. And also 369(71.4) has no detected viral load and 148(28.6) are high viral load. The hemoglobin status of those ART users 56(41.9), 60() and 401(37.2) of them are their hemoglobin very low, low and Normal hemoglobin respectively. ART adherence of those paint 357(69.05%), 129(24.95%) and 31(5.99%) of them are Good, Fair and Poor ART Adherence respectively. (Table 5).

Assessment of high viral load among adult ART service users under HIV test-and-treat program in West Hararghe Public Health Facilities

In this study, five-year Incidence of High Viral Load among adult service users on HIV test-and-treat program were assessed. Accordingly, 28.82%(95%CI:25.07,32.89) and 13.15%(95%CI:10.50,16.36) of study participants had low CD4 count and high viral load respectively. Among those who CD4 count less than 500 cells/mm³ the median time to develop low CD4 count was 19.5months(95%CI:18.03,20.76), Whereas among those who develop high viral load the median time to develop high viral load was 18 months(95%CI:14.5,22.7). The incidence to develop low CD4 count was 43.4(95%CI:36.4,50.4) per 1000 person-months of observation, Whereas the incidence to develop high viral load was 48.8(95%CI:37.2,60.5) per 1000 person-months of observation

Factors Associated with High Viral Load Among Adult ART Users

To identify factor associated with high viral load 12 variables with P-value less than 0.25 were chosen for multivariable Cox-regression. Accordingly, Place of residence, Religion, Education, Occupation, Client residence catchment with health facility, Functional status, WHO clinical stage, TB prophylaxis use

status, Opportunistic infection, Body mass index, Hemoglobin status and CD4 status are all included. After controlling for potential confounding effects on the outcome variable, factors such as Place of residence, Opportunistic infection, WHO Clinical Stage and low CD4 status remained significantly associated with viral load status. As a result, ART service user rural resident was 1.92(AHR = 1.92,95%CI:1.05–3.52) times higher chance to develop high viral load count when compared with urban resident. Similarly, ART service user who had opportunistic infection were 3.38(AHR = 3.38,95%CI:1.61–7.15) times more likely to develop high viral load count when compared with who had no opportunistic infection. Furthermore, art service user those who had WHO Clinical Stage 2 were 0.13(AHR = 0.13,95%CI:0.02–0.66) times more likely to develop high viral load count when compared with those who had stage 4 of WHO clinical stage. Likewise, Art service user those who had low CD4 count were 5.26(AHR = 5.26,95%CI:3.06–9.03) times more chance to became high viral load count when compared with those high CD4 count. (Table 6)

Discussion

The result of this study showed that the proportion low CD4 and high viral load were 28.82% (95%CI:25.07,32.89) and 13.15%(95%CI:10.50,16.36) respectively. Among those who develop low CD4 count the median time to develop low CD4 count was 19.5months(95%CI:18.03,20.76), Whereas among those who develop high viral load the median time to develop high viral load was 18 months(95%CI:14.5,22.7). The incidence to develop low CD4 count was 43.4(95%CI:36.4,50.4) per 1000 person-months of observation, Whereas the incidence to develop high viral load was 48.8(95%CI:37.2,60.5) per 1000 person-months of observation.

This finding had supported by the study conducted across four countries in sub-Saharan Africa the overall proportion of test results with a CD4 count above 500 cells/ul increased from 37.1% in 2012 to 41.8% in 2016, The median CD4 count was less than 500 cells/ul in all countries and across years. In 2016, Zimbabwe had the lowest median CD4 count of 425 cells/ while Uganda had the highest median CD4 count of 469 cells/ul. (Lamp, 2020). Other study conducted in Nigeria While 81.7% had CD4 count of < 500 cells/mm³, consisting of 14.3% with CD4 count of between 350–500 cells/mm³, 67.4% with CD4 < 350 cells/mm³ and 42.4% with CD4 count < 200 cells/mm³. Only (12.9%) had CD4 count of < 50 cells/mm³. A total of (12.6%) had CD4 count between 350–500 cells/mm³, while 72.3% had CD4 count < 350 cells/mm³, 48.3% with CD4 count < 200 cells/mm³. (Akinbami, 2012)

This study reveals a significant association between the place of residence and the likelihood of developing a high viral load among individuals receiving ART. Specifically, those residing in rural areas were found to have a 92% higher risk of developing a high viral load compared to their urban counterparts. This suggests that geographical location plays a crucial role in virological outcomes for HIV management. Supporting this finding, a retrospective follow-up study in Northern Ethiopia showed that urban residents had a 55% reduction in viral load (VL) counts compared to rural residents ($\beta = -0.55$, $p = 0.009$) (Direess and Linger, 2020). Additionally, a study in Uganda found that the odds of failing to monitor viral load were lower among urban residents (AOR 0.46), and rural patients were 6.3 times more

likely to have a detected viral load than urban patients (AOR = 6.30, $p = 0.0043$). (Opito et al., 2020). Rural patients also had lower CD4 cell counts at care initiation, which might be due to the proximity to clinics, travel distances, and access to monitoring services. The rural-urban disparity in virological outcomes may be influenced by these logistical barriers.

This study found that ART users with opportunistic infections (OIs) were 3.38 times more likely to develop a high viral load compared to those without OIs. Similarly, a study in urban Uganda reported that higher viral loads increased the hazard ratio (HR) for developing OIs by 2.42 per 1 log increase (Weissberg et al., 2018). In Pune, India, individuals with high viral loads were at significant risk for OIs across all CD4 count ranges (Ghate et al., 2009). These findings highlight the interplay between viral load and the development of OIs, emphasizing the importance of managing viral load to prevent OIs. Differences in study design, population profiles, and ART adherence levels may account for variations in findings across studies.

In this study demonstrated that individuals in WHO Clinical Stage 2 were 87 times less likely to develop a high viral load compared to those in Stage 4, with an adjusted hazard ratio (AHR) of 0.13. This aligns with a retrospective study in Zewditu Memorial Hospital, Ethiopia, where the odds of having a detected viral load for patients in WHO Stage I were decreased by 99.96% compared to Stage IV (AOR 0.0004) (Agegn Gwadu et al., 2023). Similarly, patients in WHO Stage II had a 99.95% reduction in odds compared to those in Stage IV (AOR 0.0005) (Mamo et al., 2022). In Southeast Ethiopia, WHO Stage IV patients were 4.61 times more likely to develop virological treatment failure compared to Stage I. The severity of AIDS symptoms in WHO Stages III and IV necessitates early intervention and rigorous follow-up to minimize treatment failure.

This study found that individuals with low CD4 counts were 5.26 times more likely to develop a high viral load compared to those with high CD4 counts. A study in China corroborated this, showing a higher mean viral load and lower CD4 count at ART initiation (Farmer et al., 2016). Similarly, in South Africa, patients with baseline CD4 counts ≥ 500 cells/ μL had better virological outcomes, supporting early ART initiation to achieve the UNAIDS “90-90-90” target (Fatti et al., 2020). Reasons for increased VF among those with low baseline CD4 count include low CD4 count being a marker of lower HIV-specific host immune responses and higher baseline VL, which are predictors of subsequent viremia and VF. In Kenya, patients with CD4 counts between 351–500 cells/ mm^3 and those with counts > 500 cells/ mm^3 had lower risks of virological failure (Maero, 2019). In the USA, a majority of ART users reported suppressed viral loads and high CD4 counts (Arnold et al., 2015). The reason might be the association between low CD4 counts and high viral loads may be due to lower HIV-specific host immune responses and higher baseline viral loads, which are predictors of subsequent viremia and virological failure.

Conclusion

A significant proportion of adult ART service users enrolled in the HIV Test and Treat program have a high viral load. Place of residence, Opportunistic infection, WHO Clinical Stage and low CD4 status

remained significantly associated with high viral load status among adult ART users enrolled in the test and treat program. While the program has led to a significant reduction in HIV-related morbidity and mortality, the ongoing presence of low CD4 counts and high viral loads in a considerable proportion of individuals underscores the need for continuous monitoring, targeted interventions, and strategies to enhance success of the program. Future intervention strategies should address challenges such as gender dynamics in program design and implementation, pain management, and enhancing the nutritional status of ART attendees, among other factors.

Acronyms

AOR: Adjusted Odds Ratio; ART: Antiretroviral Therapy; CI: Confidence interval; HAART: highly active antiretroviral therapy; HIV: Human immunodeficiency virus; WHO: World Health Organization, VL-Viral load, UTT- Universal test and treat

Declarations

Ethics approval and consent to participate

This study adhered to the principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of Haramaya University, College of Health and Medical Sciences. Formal permission was secured by presenting an authorization letter from the School of Graduate Studies to the West Hararghe Zone Health Office and the respective ART site health facility administrations. Informed, voluntary, written consent was obtained from the heads of the health facilities before data collection commenced. Participants were informed that the study posed no harm, and they retained the right to withdraw at any time without penalty. To uphold confidentiality, no personally identifiable information was recorded, and all collected data were treated with strict confidentiality throughout the research process.

Consent for publication

Availability of data and materials

The corresponding author will provide the necessary file and data related with this study on reasonable request.

Competing interests

The authors declare that there is no conflict of interest

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Author Contribution

JZ, AA, and ET have conceived of the study, carried out the overall design and execution of the study, design of questionnaires, performed the data collection, performed the statistical analysis and served as the lead author of the manuscript. Finally, all authors approved the final manuscript for journal submission.

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Tables

Table 1:Socio-demographic characteristics of adult antiretroviral therapy users at public health facilities in West Hararghe zone, eastern Ethiopia 2023.

Health Facility	Male		Female		Total	
	Frequency	%	Frequency	%	Frequency	%
Chiro Hospital	99	42.67	133	57.33	232	100.00
Gelemso Hospital	62	37.58	103	62.42	165	100.00
Bedesa HC	20	44.44	25	55.56	45	100.00
Hirna HC	18	45.00	22	55.00	40	100.00
Micheta HC	16	45.71	19	54.29	35	100.00
Total	215	41.59	302	58.41	517	100.00
Age by years						
15 - 25 years	10	29.41	24	70.59	34	100.00
26 - 35 years	69	31.51	150	68.49	219	100.00
36 - 45 years	80	46.78	91	53.22	171	100.00
46 - 55 years	46	60.53	30	39.47	76	100.00
56 - Over	10	58.82	7	41.18	17	100.00
Total	215	41.59	302	58.41	517	100.00
Place of residence						
urban	132	38.82	208	61.18	340	100.00
Rural	83	46.89	94	53.11	177	100.00
Total	215	41.59	302	58.41	517	100.00
Education status						
Illiteracy	30	34.09	58	65.91	88	100.00
Primary school	54	37.50	90	62.50	144	100.00
Secondary school	27	29.35	65	70.65	92	100.00
Graduate	104	53.89	89	46.11	193	100.00
Total	215	41.59	302	58.41	517	100.00
Religion						
Orthodox	92	43.19	121	56.81	213	100.00
Muslim	67	38.51	107	61.49	174	100.00
Protestant	47	41.96	65	58.04	112	100.00

Catholic	9	50.00	9	50.00	18	100.00
Total	215	41.59	302	58.41	517	100.00
Occupation						
Governmental employee	83	55.53	67	44.67	150	100
NGO	4	36.36	7	63.64	11	100
Merchant	39	32.23	82	67.77	121	100
Jobless	89	37.87	146	62.13	235	100
Total	215	41.59	302	58.41	517	100
Marital status						
Single	33	44.00	42	56.00	75	100
Married	127	39.94	191	60.06	318	100
Divorce	28	43.75	36	56.25	64	100
Widowed	27	45.00	33	55.00	60	100
Total	215	41.59	302	58.41	517	100
Client residence within the catchment area						
In the catchment area	187	40.92	270	59.08	457	100
Out of catchment	28	46.67	32	53.33	60	100
Total	215	41.59	302	58.41	517	100

Table 2:HIV Screening of adult antiretroviral therapy users at public health facilities in West Hararghe zone, eastern Ethiopia 2023.

	Male		Female		Total	
ART initiation Time	Frequency	%	Frequency	%	Frequency	%
Early initiate ART	184	42.01	254	57.99	438	100
late Initiate ART	31	39.24	48	60.76	79	100
Total	215	41.59	302	58.41	517	100
Client set HIV prevention plan						
Agreed to disclose to partner/friend/family	1	20.00	4	80	5	100
Agreed to bring children for test	0	0.00	1	100.00	1	100
Discussed and agreed to practice safer sex	53	43.09	70	56.91	123	100
Assessed for STI	154	41.05	226	58.95	380	100
Client manages for STI	5	62.50	3	37.50	8	100
Total	215	41.59	300	58.41	517	100
Functional status						
Working	196	41.35	278	58.65	474	100
Ambulatory	14	43.75	18	56.75	32	100
Bedridden	6	54.55	5	45.45	11	100
Total	215	41.59	302	58.41	517	100
WHO HIV clinical stage status						
First Stage	142	42.01	196	57.99	338	100
Above Second Stage	73	40.78	106	59.22	179	100
Total	215	41.59	302	58.41	517	100

Table 3: Opportunistic Infection, Adherence and Assessment of pain of adult antiretroviral therapy users at public health facilities in West Hararghe zone, eastern Ethiopia 2023.

	Male		Female		Total	
TB prophylaxis used	Freq	%	Freq	%	Freq	%
Yes	190	41.21	271	58.79	461	100
No	25	44.64	31	55.36	56	100
Total	215	41.59	302	58.41	517	100
TB treatment status						
TB-RX-C-complete anti TB Treatment	23	35.38	42	64.62	65	100
TB-RX-DC-discontinued	1	0.00	0	0.00	1	100
Total	24	36.36	42	63.64	66	100
Is Cervical cancer screened						
Yes	0	0	295	100	295	100
No	0	0	7	100	7	100
Total	0	0	302	100	302	100
Opportunistic infection status						
Yes	76	40.86	110	59.14	186	100
No	139	41.99	192	58.01	331	100
Total	215	41.59	302	58.41	517	100
Which IO (multiple response might be possible)						
Zoosters	10	37.04	17	62.96	27	100
Respiratory Disease	37	47.44	41	52.56	78	100
Oral Ulcer Disease	17	45.95	20	54.05	37	100
Diarrheal Disease	12	27.27	32	72.73	44	100
Total	76	40.86	110	59.13	186	100
Assessment of pain status						
Np-No Pain	156	42.28	213	57.72	369	100
S1 mild pain WHO Step1	18	40.91	26	59.09	44	100
S2 moderate pain WHO Step2	32	36.36	56	63.64	88	100
S3 Sever pain WHO Step3	9	56.25	7	43.75	16	100
Total	215	41.97	302	58.03	517	100

Table 4:Nutrition screening, pregnancy status and PMTCT of adult antiretroviral therapy users at public health facilities in West Hararghe zone, eastern Ethiopia 2023.

	Male		Female		Total	
Pregnant status	Frequency	%	Frequency	%	Frequency	%
Yes	0	0	1	0.33	1	0.33
No	0	0	301	99.67	301	99.67
Total	0	0	302	100	302	100
PMTCT						
Yes	0	0	1	100	1	100
Total	0	0	1	100	1	100
Do you use family planning in past 12 month						
Yes	17	7.42	212	92.58	229	100
No	198	69.44	90	31.25	288	100
Total	215	41.59	302	58.41	517	100
Which family planning method use						
condom	17	56.62	12	41.38	29	100
Oral contraceptive pills	0	0	7	100	7	100
Injection	0	0	175	100	175	100
Implanon	0	0	16	100	16	100
Abstinence (No sex)	0	0	4	100	4	100
Total	17	100	212	100	229	100
Body mass Index						
Underweight	4	33.33	8	66.67	12	100.00
Normal	170	39.53	260	60.47	430	100.00
Overweigh	35	54.69	29	45.31	64	100.00
Obese	6	54.54	5	45.45	11	100.00
Total	215	41.59	302	58.41	517	100

Table 5: Blood test for CD4, VL ARV, drugs Adherence, Hemoglobin and DSD of adult antiretroviral therapy users at public health facilities in West Hararghe zone, eastern Ethiopia 2023.

	Male		Female		Total	
CD4/mm status by copies/ml	Frequency	%	Frequency	%	Frequency	%
CD4 <500 copies/ml	44	29.53	105	70.47	149	100
CD4 >500 copies/ml	171	46.47	197	53.53	368	100
Total	215	41.59	302	58.41	517	100
Viral load status copies/ml						
High Viral load	30	44.12	38	55.88	68	100
NTD (Nothing detected)	185	41.20	264	58.80	449	100
Total	215	41.59	302	58.41	517	100
Hgb ALT/AST/Cr/CrAg status						
Severe Anemia	31	55.36	25	44.64	56	100
Moderate Anemia	18	30.00	42	70.00	60	100
Normal	166	41.40	235	58.60	401	100
Total	215	41.59	302	58.59	517	100
Cotrimoxazole adherence status						
Good Adherence	158	42.70	212	57.30	370	100
Fair Adherence	46	37.10	78	62.90	124	100
Poor Adherence	11	47.83	12	52.17	23	100
Total	215	41.59	302	58.59	517	100
ART Drug Adherence						
Good Adherence	148	41.46	209	58.54	357	100
Fair Adherence	51	39.33	78	60.47	129	100
Poor Adherence	16	51.61	15	48.39	31	100
Total	215	41.59	302	58.59	517	100
Other medication/Nutritional supplementation used						
Yes	59	38.82	93	61.18	152	100
No	156	42.74	209	57.26	365	100
Total	215	41.59	302	58.59	517	100

select type of DSD model code						
3MMD	208	41.85	289	58.15	497	100.00
ASM(6MMD)	3	25.00	9	75.00	12	100
FTAR	4	50.00	4	50.00	8	100
Total	215	41.59	302	58.59	517	100

Table -6: Factors associated with High Viral Load Status among Adult ART service Users in West Hararghe Zone Public Health Facility.

Variables	High Viral load	Censored	CHR (95%CI)	AHR (95%CI)	P-value
Place of Residence					
Urban	33(9.71)	307(90.29)	1	1	
Rural	35(19.77)	142(80.23)	2.39(1.48-3.85)	1.92(1.05-3.52)	0.03**
Religion					
Orthodox	24(11.27)	189(88.73)	1	1	
Muslims	27(15.52)	147(84.48)	1.42(0.82-2.47)	1.24(0.66-2.32)	0.49
Protestant	14(12.50)	98(87.50)	1.13(0.58-2.19)	1.24(0.60-2.56)	0.55
Catholic	3(16.67)	15(83.33)	2.33(0.70-7.80)	1.22(0.32-4.61)	0.76
Education status					
Illiteracy	14(15.91)	74(84.09)	1	1	
Primary school	17(11.81)	127(88.19)	0.73(0.36-1.50)	1.00(0.47-2.13)	0.98
Secondary school	16(17.39)	76(82.61)	1.08(0.52-2.21)	2.22(0.99-4.95)	0.05
Graduated	21(10.88)	172(89.12)	0.62(0.31-1.23)	1.08(0.45-2.56)	0.85
Occupation					
Government	15(10.00)	135(90.00)	1	1	
Non-government	1(9.09)	10(90.90)	1.29(0.17-9.77)	3.73(0.45-30.81)	0.22
Merchant	11(9.09)	110(90.91)	1.06(0.49-2.33)	1.51(0.59-3.85)	0.38
Jobless	41(17.45)	194(82.55)	1.93(1.07-3.49)	2.03(0.92-4.47)	0.07
Client residence catchment					
In Catchment	55(12.04)	402(87.96)	1	1	
Out of Catchment	13(21.67)	47(78.33)	2.02(1.10-3.70)	0.75(0.33-1.66)	0.48

Functional Status					
Work	58(13.23)	416(87.76)	1	1	
Ambulatory	11(19.23)	21(80.77)	1.63(0.65-4.09)	1.26(0.47-3.32)	0.64
Bedridden	5(45.45)	6(54.54)	10.18(4.04-25.64)	1.77(0.60-5.21)	0.29
WHO Clinical Stage					
Stage 4	5(41.67)	7(58.33)	1	1	
Stage 1	46(12.47)	323(87.53)	0.52(0.20-1.32)	0.89(0.29-2.73)	0.84
Stage 2	5(7.25)	64(92.75)	1.41(0.74-2.66)	0.13(0.02-0.66)	0.01**
Stage 3	12(17.91)	55(82.09)	3.53(1.40-8.89)	0.38(0.11-1.22)	0.10
TB prophylaxis User					
No	11(19.64)	45(80.36)	1	1	
Yes	57(12.36)	404(87.64)	0.60(0.31-1.14)	0.76(0.35-1.63)	0.49
Opportunistic Infection Status					
No	34(17.80)	157(82.20)	1	1	
Yes	34(10.43)	292(89.57)	0.59(0.36-0.95)	3.38(1.61-7.15)	0.001**
Body Mass Index					
Under weight	2(16.66)	10(83.33)	1	1	
Normal weight	58(13.18)	372(86.82)	0.31(0.07-1.29)	0.44(0.09-2.16)	0.31
Over weigh	7(10.94)	57(89.06)	0.26(0.05-1.27)	0.27(0.04-1.57)	0.14
Obesity	1(9.09)	10(90.90)	0.85(0.07-9.43)	0.88(0.06-11.37)	0.92
Hemoglobin					
Severe Anemia	15(26.79)	41(73.21)	1	1	
Moderate Anemia	5(8.33)	55(91.67)	0.32(0.11-0.88)	0.56(0.15-2.08)	0.39

Normal	48(11.97)	353(88.03)	0.52(0.29-0.93)	0.52(0.25-1.04)	0.06
CD4 Status of HIV Patient					
High cd4	32(8.70)	336(91.30)	1	1	
Low cd4	36(24.16)	113(75.84)	4.42(2.72-7.19)	5.26(3.06-9.03)	0.00**

Figures

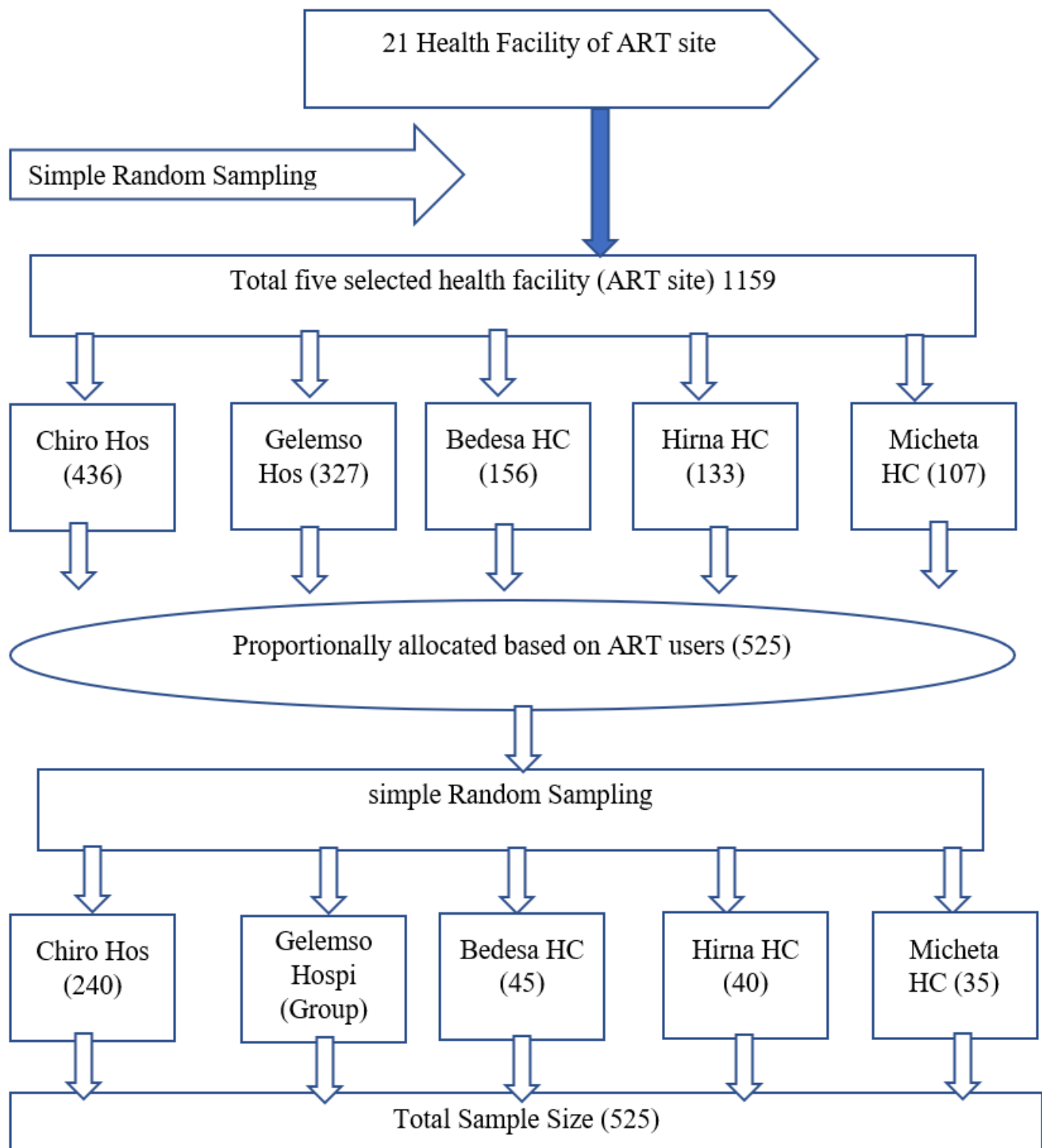


Figure 1

Sampling procedures on Incidence of High Viral Load among adult service users under HIV test and treat program in west hararghae public health facilities, eastern Ethiopia