

# Trends Analysis of HIV Infection and Antiretroviral Treatment Outcome in Amhara Regional from 2015 to 2021, Northeast Ethiopia

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**Background:** The persistent efforts of HIV/AIDS epidemiology remain one of the world's most important community health threats. To avoid becoming an epidemic, UNAIDS has set three 90% fast-track targets for 2020, and Ethiopia has also changed its implementation since 2015. However, the achievement targets in the Amhara region have yet to be evaluated at the end of the programme period.

**Objective:** The aim of this study was to assess the Trends of HIV Infection and Antiretroviral Treatment outcome in Eastern Amhara Regional from 2015 to 2021, Northeast Ethiopia.

**Methods:** A retrospective study was conducted by reviewing the District Health Information System from 2015 to 2021. The collected data includes the trend of HIV testing services, the trend of HIV positivity, the yield of HIV testing approaches, the number of HIV positive patients linked to HIV care and treatment or access to lifelong antiretroviral therapy, viral load testing coverage, and viral suppression. A descriptive statistic and trend analysis were computed.

**Results:** A total of 145,639 people accessed antiretroviral therapy. The trend of HIV test positivity has been declining since 2015, peaking at 0.76% in 2015 and declining to 0.60% in 2020. A high level of positivity was reported in volunteer counselling and testing as compared with provider-initiated testing and counselling services. Following an HIV positive, there was an increase in linkage to HIV care and treatment. High suppression rates of viral load indicate testing coverage grew over time. The viral load monitoring coverage was 70% in 2021, with a viral suppression rate of 94%.

**Conclusion and Recommendations:** The trend in achievement in the first 90s was not consistent with predefined goals (90%). On the other hand, there was good achievement in the second and third goals. Hence, intensified case-finding approaches to HIV testing should be strengthened.

**Keywords:** HIV, antiretroviral treatment outcome, trends

## Introduction

Viral load test is the preferred monitoring method for people living with HIV/AIDS (PLWHA) on antiretroviral therapy (ART). Monitoring viral load (VL) is used to assess the treatment progress, to detect treatment failure, and to assess transmission risk.<sup>1</sup> Despite the persistent efforts to finish the HIV/AIDS epidemic, it remains one of the world's most important public healthiness terrorizations and a target to the Sustainable Development Goal (SGD) 2030.<sup>2</sup> The highlights of this report indicate the gradual decline in PLHIV that were estimated in 612,925 for the year 2021 to 609,349 for the year 2022, and also adult HIV new infection declined from 8772 to 8284 for the year 2021 and 2022, respectively.<sup>3</sup> According to the Joint United Nations Programmed on HIV/AIDS (UNAIDS) report, 37.7 million people internationally were living with HIV in 2020, and Africa accounts for 25.5 million, of which eastern and southern Africa takes 80.7%. Regarding the incidence of HIV infection, globally there were around 1.5 million newly infected individuals, of which

nearly a million occurred in Africa.<sup>4</sup> Globally, in the year 2020 about 680,000 people died from AIDS-related illnesses. Eastern and southern Africa accounts for half of the global AIDS-related deaths. Meanwhile, at the start of the widespread, 79.3 million [55.9 million–110 million] people have become infected with HIV and 36.3 million [27.2 million–47.8 million] people have died from AIDS-related illnesses. Globally, 28.2 million people living with HIV (PLHIV) were accessing antiretroviral therapy (ART) as of 30 June 2021.<sup>5</sup>

HIV medicines prevent HIV from multiplying (making copies of itself), reducing the amount of HIV in the body (known as the viral load). Less HIV in the body allows the immune system to recover and produce more CD4 cells.<sup>6</sup> Reports showed after 12 months taking of ART, the virological suppression achievement was 80%. This is within the range of 71–84% of patients showing viral suppression after 12 months of ART.<sup>7,8</sup>

According to the Ethiopia Public Health Institute HIV estimate in 2020, 745,719 people living with HIV and 8426 annual deaths related to HIV/AIDS were reported.<sup>9,10</sup> Similarly, according to the Ethiopian demographic and health Survey 2016 (EDHS 2016), in countrywide the HIV occurrence was 0.9%.<sup>11,12</sup> The prevalence varies greatly by gender, geography, age, and socioeconomic status. In terms of the regional distribution of HIV estimation, the Amhara region is one of the highest-burden regions, with approximately 212,991 people living with HIV in 2020.<sup>13</sup> Although the overall prevalence HIV/AIDS in Ethiopia's is less than the epidemic threshold (1%) in eight regions, including Amhara, have a prevalence greater than 1% and are classified as HIV epidemic regions. In Ethiopia, 48,000 HIV-positive people will have received antiretroviral therapy by 2020.<sup>14,15</sup>

In response to this epidemic, WHO declared three 90-90-90 fast-track targets to accomplish the Sustainable Development Goals (SDG) to end the epidemic of AIDS by 2030 within the context of confirming healthy lives and promoting well-being for all at all ages.<sup>16</sup> In 2021, UNAIDS updated its fast-track targets to three: 95% of people living with HIV will know their HIV status; 95% of people who know their HIV status will receive antiretroviral therapy (ART), and 95% of those who receive ART will have viral suppression. In line with this, Ethiopia has endorsed the UNAIDS fast track targets by incorporating them into its National Strategic Plans (NSP) since 2015. The current Ethiopian National Strategic Plan (NSP) for HIV, 2021–2026, aims to achieve national HIV epidemic control by 2026, with new HIV infections and AIDS mortality rates of less than one per 10,000 people.<sup>17</sup>

In order to meet the predetermined goals, the World Health Organization (WHO) strengthened enhanced HIV testing service (HTS) and launched treat-all approach as a new treatment initiation criterion in 2016.<sup>1</sup> Enhanced HIV case identification to achieve first 90s or 95s has been implemented using different HIV testing modalities including volunteer counseling and testing (VCT) and provider-initiated testing and counseling (PITC) services. Then, the identified HIV positive cases will be linked to HIV care and treatment or will have access to lifelong antiretroviral therapy using rapid initiation approach (test and treat).<sup>18</sup> This allows to achieve the second 90s or 95. In this new treatment approach, any HIV-positive client will initiate antiretroviral therapy regardless of CD4 cell count as well as the clinical stage of the disease. Previously, antiretroviral treatment was initiated based on the level of CD4 cell count and WHO clinical stages. Antiretroviral treatment will be started for HIV patients with a CD4 cell count of fewer than 500 cells/mm<sup>3</sup> or in advanced clinical stages (Stage III or IV).<sup>19</sup>

The aims of antiretroviral therapy are to decrease viral load, improve CD4 cells, reduce the occurrence of opportunity infections, and improve overall health-related quality of life. Additionally, to suppress viral load less than 1000 copies/mL after first second-line antiretroviral therapy.<sup>20</sup> In Ethiopia, viral load testing on the top 20 problematic areas began in 2016. The viral load test is considered the gold standard for monitoring treatment outcomes in HIV patients. As a result, 90% to 95% of those on ART are expected to achieve viral suppression.<sup>21</sup>

Despite the government of Ethiopia has already launched the 2nd HIV/AIDS national strategic plan of Ethiopia (2021–2025), there is gap of treat-all approach and launching viral load testing as routine monitoring treatment outcomes, the progress towards achieving the three 90s was not evaluated in Amhara regional state perspectives. Knowing the current progress allows to craft appropriate action points for the achievement of three 95% the next five years as well as serve as baseline data for later comparison. Hence, the aim of this study was to assess the trends of HIV infection and antiretroviral treatment outcomes in Eastern Amhara Regional state from 2015 to 2021 from District Health information system (DHIS-2).

## Methods

### Study Area, Period and Setting

This study was carried out in Amhara regional state, Ethiopia. The Amhara Region is located in the northwestern part of Ethiopia between 8° 45' and 13° 45' North latitude and 36° 20' and 40° 20' East longitude. It has an estimated land area of 17.7 million square kilometers. Amhara is bordered to the north by Tigray Region, to the east by Afar, to the south by Oromia, to the southwest by Benishangul-Gumuz, and to the west by Sudan. Amhara is divided into 13 zones, each with eight town administrations. Agew Awi, East Gojjam, the Oromia specialty zone, North Gondar, North Shewa, North Wollo, South Gondar, South Wollo, Wag Hemra, West Gojjam, West Gondar, Welkayit Tegeda Setit Humera, and Central Gondar are some of these zones. By 2022, those zones, or the Amhara region, are expected to have a population of 23,115,999 people.

The HIV data was held by SMART care, the ART logbook, and the chronic ART follow-up form and reported in DHIS-2. Following each clinical appointment, these registries are updated. Every facility in the country uses the same documentation and reporting system. HIV patients are scheduled every three months in the COVID-19 era. At each appointment, patients will be evaluated for nutritional status, opportunistic infections, medication adherence, drug side effects, and the need to refill ART and other preventative medications.

### Study Design and Data Collection

A retrospective study was carried out by reviewing the district health information system (DHIS-2) in the Amhara region from 2015 to 2021. Data on the trend of HIV testing services, the trend of HIV positivity, the yield in various HIV testing approaches, the number of HIV positive patients were linked to HIV care and treatment or access to lifelong ART, viral load testing coverage, and viral suppression were collected.

### Source and Study Population

All clients who were diagnosed as HIV positive and HIV patients who have been receiving second-line antiretroviral therapy from 2015 to 2021 were considered as a source population for the trend analysis of antiretroviral treatment access, and those clients who were initiated antiretroviral treatment during the study period were considered as a source population for the trend assessment of viral load test coverage and viral re-suppression status.

### Eligibility Criteria

All clients who experienced HIV testing service were enrolled in HIV care and treatment, and who had viral load records or tested were included in this study. All collected data in DHIS-2 during the study period were included.

### Variables and Measurement

Number of HIV testing services (VCT and PITC approaches), Trend of HIV positivity and overall yield, Trend of HIV positive linkage or enrollment to HIV care and treatment, Trend of viral load coverage and viral suppression. Viral re-suppression or low viremia level is defined as having a viral load quantity under 1000 copies/mL at least six-month taking to second-line antiretroviral therapy.<sup>22</sup>

### Data Collection Procedures

Standardized checklist was used to collect and extraction by reviewing regional District health information system (DHIS-2). DHIS2 is an open source, platform with web-based that commonly used as a health management information system (HMIS). Accordance with the national consolidated antiretroviral guideline the extraction sheet was created in.<sup>23</sup>

### Data Quality Assurance

To confirm the data's quality, the following steps were taken: Data collectors were trained on the purpose of the study, the content of the check list, and how to gather the necessary data over a two-day period. To ensure data quality, the extraction sheet was pre-tested on a head of the actual study. The data collection procedures were carefully monitored, and feedback was provided on site. In accordance with Ethiopia's antiretroviral treatment guidelines, the extraction sheet was written in English.

The checklist will be pretested, and any necessary changes will be made. Furthermore, data were collected by triangulating three data sources: the ART registration book, the follow-up card, and the ART database, to reduce data incompleteness. The data were entered into the Epidata Version 4.0.06 software package, and templates were programmed using Epidata check codes. Furthermore, exploratory data analysis will be carried out and possible errors managed.

## Data Processing and Management

After data gathering, the completeness of the checklist was checked and entered into the Epi-Data Version 4.0.0.6 software package. The data were exported to Statistical Package for Social Science Version 25 statistical software as well as Stata Version 14 for further investigation. Exploratory data analysis was conducted in order to check possible errors, assumptions, and computing, transformation, or recoding prior to actual data analysis.

## Data Analysis

A descriptive statistic was computed to describe the trend of the proposed objectives. For categorical variables, frequency and percent were computed and presented in a table and graph. For a continuous variable, first Kolmogorov–Smirnov and Shapiro–Wilk tests were used to check the distributional assumptions. The mean with standard deviation (SD) and median (interquartile range, IQR) were employed to check normally and skewedly distributed of continuous variables, respectively. Trend analysis was computed to see how the longitudinal trend changed across the proposed objectives.

## Ethical Considerations

This study was conducted according to the Helsinki Declaration. The Ethical Review Board of Wollo University was granted ethical approval. Permission was also obtained from the respective zonal health departments. The informed consent was waived because we used document review as a data source. Besides, to keep the data private, anonymous techniques were employed throughout the research process.

## Results

### Study Description

This study reviewed HIV data (DHIS-2) for the Amhara region from 2015 to 2021. During the last observation period of 2021, a total of 145,639 people accessed antiretroviral therapy, of which more than 90% were adults aged greater than 14 years old. The trend of ART coverage was shown to have an improved pattern; from 113,992 in 2015 to 145,639 in 2021. The following are the yearly trends of HTS, access to ART or linkage to care and treatment, viral load suppression rate, and the trend of three 90s achievement. The trend of ART treatment access had shown a significant improvement as you moved from 2015 to 2021. During 2016 there were significant improvements in enrolment to HIV care and treatment (Table 1 and Figure 1).

**Table 1** Antiretroviral Treatment (ART) Coverage in Amhara Regional State, from 2015 to 2021

Year	Adults $\geq 15$ on ART	Children $< 15$ on ART	Currently on ART
2015	108,049	5943	113,992
2016	116,673	6535	123,208
2017	122,379	6161	128,540
2018	131,872	5807	137,679
2019	135,506	5621	141,127
2020	137,317	4993	142,310
2021	141,174	4465	145,639

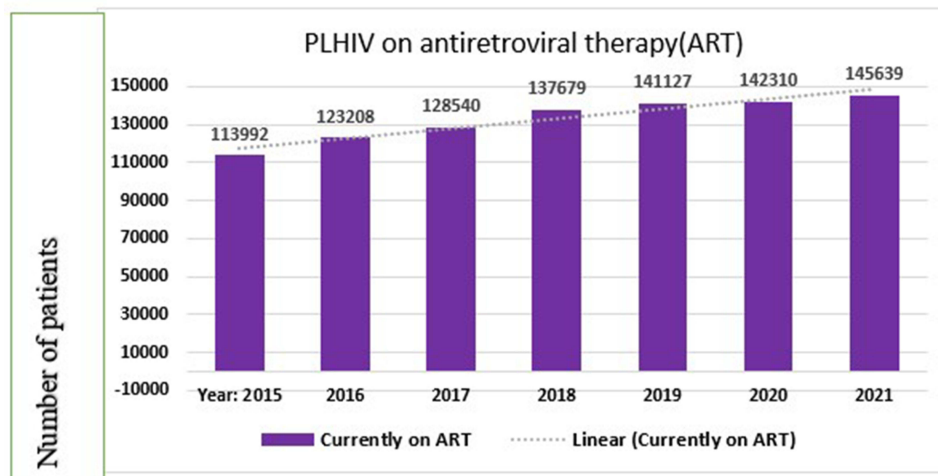


Figure 1 Trend of Antiretroviral treatment (ART) coverage in Amhara regional state, from 2015 to 2021.

### Trend of HIV Testing and Counselling (HTC) Services

From 2015 to 2021, there was a general trend of declining HTC service coverage. Both volunteer counseling and testing (VCT) and provider-initiated testing and counseling (PITC) service coverage also showed a downward trend. With regard to the trend of HIV test positivity, or yield, it has been declining since 2015, peaking at 0.76% in 2015 and declining to 0.60% in 2020. The highest HIV positivity yield from HTS approaches was found in VCT, where the maximum yield was 1.03% in 2017 and the lowest was 0.71%. The lowest yield was displayed by PITC, while the greatest yield was 0.64% in 2017 (Table 2, Figures 2 and 3).

### Linkage to Care and Treatment

The overall trend of linkage to care and treatment following HIV positive results has shown a slightly increased pattern since 2018. Similar to that, from 2015 and 2017 there was an increasing trend. The highest peak of linkage to care and treatment was observed in 2017 and the lowest was in 2015 (79%) (Table 3 and Figure 4).

### Viral Load Coverage and Suppression

High viral load suppression rates increased as viral load testing coverage grew over time. The viral load monitoring coverage surpassed 70% in 2021, with a total viral suppression rate of 94%. The viral load coverage has significantly

Table 2 Trend of HIV Testing and Counselling (HTC) Services Coverage and Yields in the Amhara Region, 2015–2021

Year	Overall HTC			PITC			VCT		
	Tested	Positive	Yield (%)	Tested	Positive	Yield (%)	Tested	Positive	Yield (%)
2015	2,376,054	17,942	0.76%	1,406,219	8505	0.60%	969,835	9437	0.97%
2016	1,990,347	12,521	0.63%	1,451,073	7254	0.50%	539,274	5267	0.98%
2017	1,723,788	12,715	0.74%	1,277,065	8124	0.64%	446,723	4591	1.03%
2018	2,121,311	13,895	0.66%	1,545,359	8877	0.57%	575,952	5018	0.87%
2019	1,763,090	11,578	0.66%	1,271,009	7072	0.56%	492,081	4506	0.92%
2020	1,435,584	8588	0.60%	1,038,238	5531	0.53%	397,346	3057	0.77%
2021	1,482,352	9018	0.61%	1,082,403	6188	0.57%	399,949	2830	0.71%

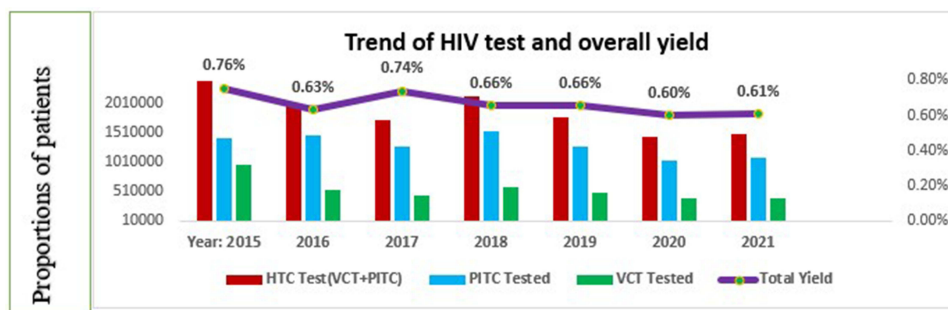


Figure 2 Trend of HIV testing and counselling (HTC) services in the Amhara region, 2015–2021.

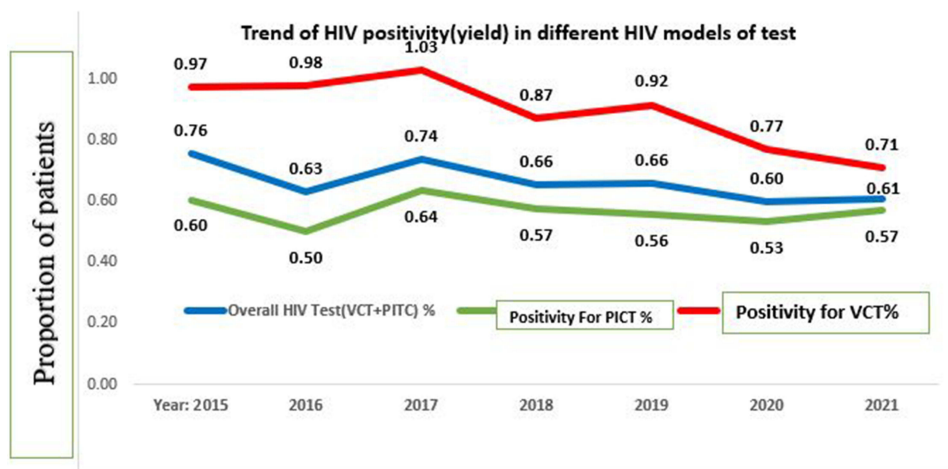


Figure 3 Trend of HIV positivity or yield in different HTC approaches in the Amhara region, 2015–2021.

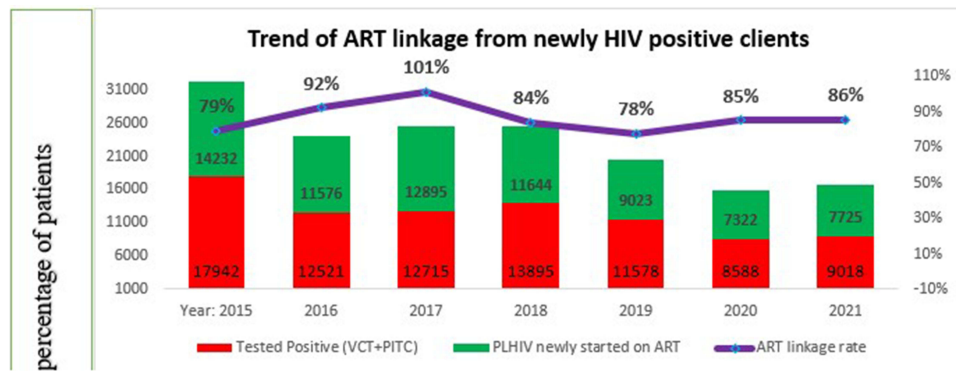
improved since 2019. Prior to that, it was insufficient, with only 3 out of 10 PLHIV accessible for viral load testing services. The highest viral load suppression rate was observed in 2021 (94%), and the lowest was observed in 2015 (38%) (Table 4 and Figure 5).

### Trend in the Achievement of Three 90s

Over the previous seven years, the first-90s achievement trend—which was around 71%—has not changed. This means, only seven out of ten HIV-positive individuals were knowing their positive HIV status during the last seven years of HTC

Table 3 Trend of Linkage to Care and Treatment Among Newly HIV Positive Clients in the Amhara Region, 2015–2021

Year	Overall HTC Positive	PLHIV Newly Started on ART	ART Linkage Rate
2015	17,942	14,232	79%
2016	12,521	11,576	92%
2017	12,715	12,895	101%
2018	13,895	11,644	84%
2019	11,578	9023	78%
2020	8588	7322	85%
2021	9018	7725	86%



**Figure 4** Trend of linkage to care and treatment among newly HIV positive clients in the Amhara region, 2015–2021.

service. Concerning the second 90s (ie, 90% of PLHIV accessed care treatment among those who recognize their HIV positive status), the highest peak of achievement was observed in 2017 and since then it has demonstrated a pattern of growth. Regarding the trend of the third 90s (ie, 90% of PLHV achieved viral suppression among those who were on antiretroviral therapy), there had been a remarkable improvement from 38% in 2015 to 94% in 2021 (Table 5 and Figure 6).

## Discussion

This study designed to show the trend of HIV testing service utilization, linkage to care and treatment, viral load test coverage and viral suppression as well as three 90s achievement trends for the last six-year period in Amhara regional state.

The coverage of HTS has declined in the last six years in both the VCT and PITC approaches. In the current study both volunteer counseling and testing (VCT) and provider-initiated testing and counseling (PITC) service coverage also showed a downward trend. With regard to the trend of HIV test positivity, or yield, it has been declining since 2015, peaking at 0.76% in 2015 and declining to 0.60% in 2020. The highest HIV positivity yield from HTS approaches was found in VCT, where the maximum yield was 1.03% in 2017 and the lowest was 0.71%. The lowest yield was displayed by PITC, while the greatest yield was 0.64% in 2017. Similarly, research showed on the trend of yield or HIV positivity also shows a decrement pattern, which is consistent with the national level of HIV yield or positivity in 2017 and 2018.<sup>24</sup> This result indicated that the emphasis on achieving the first 90% and screening for high-risk HIV testing services decreased over time. The other pertinent finding in this study was that the trend of positivity or yield was high in VCT as compared with PITC. The possible justification for the high HIV positive yield in the VCT service might be that positive

**Table 4** Trend of Viral Load Coverage and Suppression in the Amhara Region, 2015–2021

Year	PLHIV on ART			Viral Load Tested	Suppressed Viral Load	Viral Load Test Coverage	Suppressed Viral Load
	Adult	Children (0–14)	Total				
2015	108,049	5943	113,992	1641	625	1.4%	38%
2016	116,673	6535	123,208	176	92	0.1%	52%
2017	122,379	6161	128,540	22,179	15,274	17.3%	69%
2018	131,872	5807	137,679	35,846	30,016	26.0%	84%
2019	135,506	5621	141,127	102,619	72,784	72.7%	71%
2020	137,317	4993	142,310	96,685	84,519	67.9%	87%
2021	141,174	4465	145,639	102,039	95,628	70.1%	94%

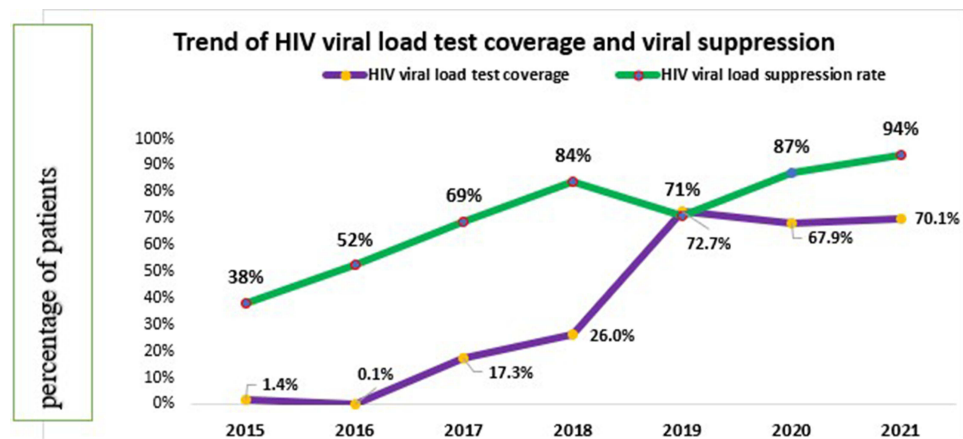


Figure 5 Trend of viral load coverage and suppression in the Amhara region, 2015–2021.

clients may repeatedly visit VCT clinics after knowing their positive status for further confirmation. Besides, it might be clients who perceive a high risk of acquiring HIV infection and may visit HTS by self-initiation. On the other hand, the practice of PITC in routine care at numerous entrance points (inpatient, outpatient, TB and STI clinics, malnutrition, and postnatal clinics) lacks a screening focus, in which PITC services are offered in conjunction with risk screening services. Hence, this result implies that the implementation of the risk screening service for HIV testing was low or not implemented in accordance with the target screening guidelines.

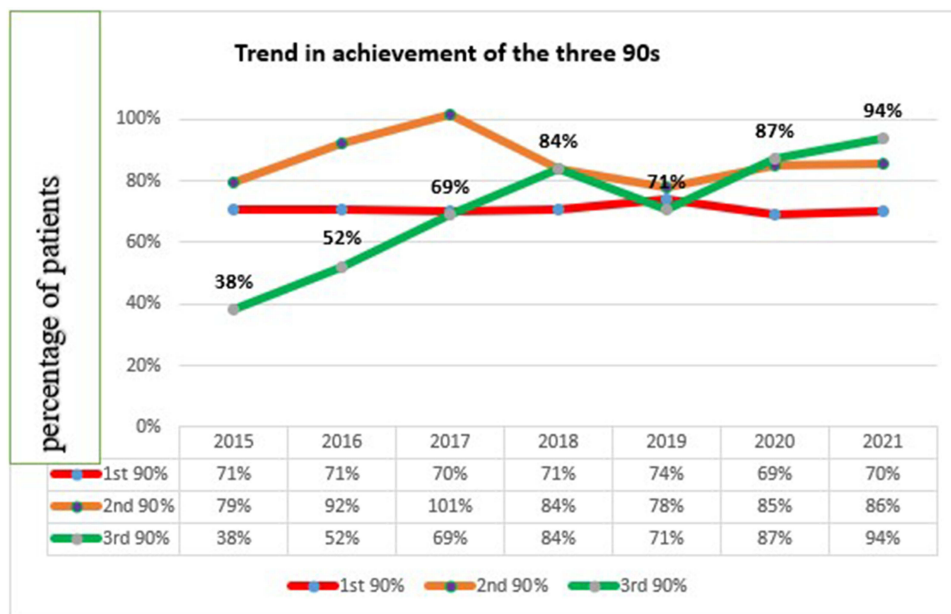
In the current study, the trend of ART coverage was shown to have an improved pattern; from 113,992 in 2015 to 145,639 in 2021. The following are the yearly trends of HTS, access to ART or linkage to care and treatment, viral load decreasing rate, and the trend of three 90s achievement. The trend of HIV-positive clients being associated to care and treatment after discovering their positive status has improved over time. This is critical in meeting the second 90% goal, which states that 90% of positive clients should have access to HIV care and treatment. The Amhara region has made good progress toward the second 90-day goal. A large number of patients were enrolled in HIV care and treatment in 2017. This was due to Ethiopia's full implementation of the new ARV treatment initiation criteria, particularly in the Amhara region. As a result, in 2017, all newly diagnosed HIV cases and all pre-ART cases received antiretroviral therapy.

The overall trend of linkage to care and treatment following HIV positive results has shown a slightly increased pattern since 2018. Similar to that, from 2015 and 2017 there was an increasing trend. The highest peak of linkage to care and treatment was observed in 2017 and the lowest was in 2015 (79%). Similarly, antiretroviral treatment adherence was positively correlated with the number of adherence counsellors. This finding is persistent with the

Table 5 Trend in the Achievement of Three 90s in the Amhara Region from 2015–2021

Year	Estimated HIV Positive	Total Positive	1st 90%	PLHIV Newly Started on ART	2nd 90%	HIV Viral Load Tested	HIV Viral Load Suppression	3rd 90%
2015	25,342	17,942	71%	14,232	79%	1641	625	38%
2016	17,635	12,521	71%	11,576	92%	176	92	52%
2017	18,164	12,715	70%	12,895	101%	22,179	15,274	69%
2018	19,570	13,895	71%	11,644	84%	35,846	30,016	84%
2019	15,656	11,578	74%	9023	78%	102,619	72,784	71%
2020	12,446	8588	69%	7322	85%	96,685	84,519	87%
2021	12,883	9018	70%	7725	86%	102,039	95,628	94%





**Figure 6** Trend in the achievement of three 90s in the Amhara region from 2015–2021.

findings of a multi-level study conducted in Cambodia.<sup>25</sup> Adherence counsellors are formally assigned non-healthcare workers who provide adherence counselling, screening for psychiatry problem and substance use issues, tracing lost to follow-up cases, one-to-one counselling, and mass education about treatment and illness.<sup>26,27</sup> As a result, in order to provide effective adherence counselling and other jobs, the number of adherence cohorts should grow in lockstep with the number of patients.

The magnitude of viral load test coverage was significantly improved in the last six-year period, in which it improved from 1.4% to 71.1%. Similarly, the viral load suppression rate also improved from 38% in 2015 to 94% in 2021. This finding was congruent with Ethiopian population-based HIV impact assessment result as well as the Amhara region had achieved the third 90 goal, in which among HIV patients who were taking ART, 90% of them should achieve viral suppression.<sup>28</sup> The history of drug substitution is linked to viral re-suppression. Frequent first-line antiretroviral drug substitution reduces secondary treatment options and forces the reuse of previously substituted drugs. As a result, there will be an increased risk of drug resistance and failure to suppress viral load, particularly in areas where drug resistance testing has not yet been implemented during drug substitution. Backbone NRTIs are used in place of drugs from the same class that were previously used in first-line antiretroviral therapy.<sup>29,30</sup>

The overall trend of three 90s achievements showed that there was an increment pattern from year to year. However, the achievement of the first 90s (70% in 2021) was below the predetermined goal (90%) in Amhara regional state. Hence, for the next five years, to achieve 95% case identification, alternative HIV case finding strategies should be adopted and deeply implemented. However, the trend of second and third 90s achievement improved across time and achieved the predetermined goals. This achievement should be strengthened in the next five years to achieve the three 90. This study revealed that eight in ten HIV patients who were getting second-line antiretroviral therapy had achieved viral suppression.<sup>31</sup> This result is inconsistent with studies conducted in resource-limited settings and is higher than a study conducted in South Africa. This variation is due to a classification difference in viral load measurement. Viral load quantities are below 400 copies/mL and 1000 copies/mL were used as cutoff points to define viral decrease in studies conducted in South Africa and the current study, respectively. In general, viral decrease in this study remains inconsistent with national and WHO/UNAIDS-set targets for viral suppression in 2030, which state that 95% of people on treatment will have suppressed viral load by 2026.<sup>32</sup> Not accomplishing viral decreasing has both clinical and public health implications. Clinically, it increases the risk of drug resistance, second-line treatment failure, and demand for high-cost third-line antiretroviral therapy. Besides, at the community level, it also rises the chance of HIV transmission, even resistant strains.

## Policy, Practice and Research Implication

The implementation of enhanced HIV case finding to achieve the first 90 was not low or the emphasis was decreased as time went by. The existing HCT service lacks identification of high-risk HIV clients. Hence, alternative and high-yield HIV testing services should be strengthened. High-yield case finding modalities include index case testing and partner notification, social network services, and PITC using an HIV risk screening tool at the health facilities. HIV positive cases from HTS sites have a good referral linkage, whether intra or inter-referral linkage. Having high viral suppression after initiation of ARV implies a significant number of HIV patients would have a better quality of life, immunological and clinical outcomes, as well as at a public level, it decreases the chance of HIV transmission even from mother to child after initiation of ARV.

## Limitations of the Study

Retrospective design was used to analyze viral re-suppression, attrition, treatment failure, and death by reviewing multiple data sources, including chronic HIV follow-up forms (patient charts or cards), ART registration books, and the SMART care database. However, we were unable to collect and analyze information on behavioral, social, and psychological aspects, as well as clinical information such as organ function tests and drug 88 resistance testing. These limitations stemmed from the data gathering procedures, which involved reviewing medical records (document review). As a result, unmeasured covariate confounding must be taken into account when interpreting the reported associations.

## Conclusion and Recommendations

Based on the result of this study, the following conclusions were made. The trend of HIV testing services and yield of positive results decreased across time in the Amhara region during the last six years. The VCT service had shown a better trend yield than that of the PITC service. The linkage of HIV positive cases to HIV care and treatment has an improved pattern across time. In the last six years, there has been a significant improvement in viral load coverage and suppression rates. The achievement of first-90 in the last six-year period was stagnant or had not shown any change, ARV treatment access and viral suppression had improved, as well as achieved the predetermined goals of the second and third-90s. The following recommendations were made based on the result of this study. Alternative molecular testing HIV testing modalities should promptly adopt and implemented in order to improve the achievement of first-90 or improve HIV case finding, the implantation of targeted HIV testing service using high risk identification tools should be enhanced in order to improve yield of PITC service, The viral load testing coverage service should also improve well.

## Abbreviations

ART, Antiretroviral Therapy; DHIS-2, District Health Information System; EDHS, Ethiopian Demographic and Health Survey 2016; FMOH, Federal Ministry of Health; HTS, HIV testing and counselling Service; IQR, Interquartile Range; NSP, National Strategic Plan; PITC, Provider-Initiated Testing and Counseling; PLHIV, People Living with HIV; SD, Standard Deviation; SDG, Sustainable Development Goal; VCT, Volunteer Counseling and Testing; WHO, World Health Organization.

## Data Sharing Statement

All data to the conclusions of this article are within the manuscript.

## Acknowledgment

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors state that they have no conflicts of interest in this research work.

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