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Providing anti-retroviral treatment did not achieve the ambition of 'Joint united nations program on HIV/AIDS (UNAIDS) among HIV positive patient in Ethiopia': a systematic review and meta-analysis

Tamirat Melis[a], Tadesse Sahle[b], Kassahun Haile[c], Abebe Timerga[d], Amare Zewdie[a], Yohannes Wegu[e], Kebebush Zepire[a] and Jemal Bedewi[a]

[a]Department of Public Health, College of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia; [b]Department of Nursing, College of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia; [c]Department of Medical Laboratory, College of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia; [d]Department of Biomedical Science, College of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia; [e]Kule Refugee Camp, Gambela health offices, Southwest, Ethiopia

ABSTRACT

Introduction: Antiretroviral Treatment (ART) has great importance in reducing viral load. Though a global effort was made to suppress viral load, the level of viral load suppression among ART patients is still high in Ethiopia.

Objective: This study aims to assess the magnitude and contributing factors for viral load suppression among patients attending ART clinics in Ethiopia.

Methods: The articles were searched using different databases using the guideline of reporting systematic review and meta-analysis (PRISMA). A random effect model was used to ascertain the pooled prevalence of viral load suppression in Ethiopia using STATA 14 software.

Results: The pooled prevalence of suppressed viral load was 75.25% (95% CI: 68.61–81.89). Having good adherence (OR: 2.71, 95% CI 2.27, 3.15), baseline CD4 count (OR: 1.74, 95% CI 1.53, 1.96), and being female (OR: 1.41, 95% CI 1.04, 1.79) were determinants of pooled estimates of suppressed viral load.

Conclusion: The pooled prevalence of suppressed viral load was 75% which is lower than the targeted level by the sustainable development goal (SDG) 2020, which was 90%. Therefore, the stakeholders should be focused on the existing strategies to decrease viral load among ART patients. They should work to adhere to patients for ART treatment.

Abbreviation and acronyms: AIDS; Acquired immunodeficiency syndrome; ART: Anti-retroviral drug therapy; CD4: Cluster of Differentiation 4; UNAIDS: United Nations Program on HIV/AIDS; WHO: World Health Organization

KEYWORDS Antiretroviral therapy; HIV infection; HIV-positive patients; suppression of viral load

CONTACT Tamirat Melis tamiratmelis27@gmail.com Department of Public Health, College of Medicine and Health Science, Wolkite University, Wolkite, Ethiopia

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Introduction

Human immune virus become a world public health important disease of the world (Stover et al. (2016)). Since the start of HIV/AIDS, more than 70 million people have tested positive and 35 million people have died because of the HIV epidemic. At the end of 2017, 36.9 million people tested positive for HIV. Africa is one of the continents which have high HIV infection. The prevalence of HIV in Africa in 2017 was 4.1% (WHO (2019)). Ethiopia is also one of the countries which had been affected by HIV epidemics. In Ethiopia, about 729,089 people living with HIV, 21,606 HIV incident cases, and 10,960 mortality were reported in 2018 (HAPCO/EPHI (2017)).

The treatment outcome of HIV-positive patients was monitored using CD4 T-cell counts and clinical staging of WHO criteria (Hailemariam et al. (2013)). The golden standard for the monitoring of HIV treatment (routine viral load testing), was recommended by WHO in 2013 (WHO (2017)). The Ethiopian HIV care and treatment guideline enforce that viral load should be done routinely. In Ethiopia, routine viral load testing was started since 2016 (Hull & Montaner, 2011; Zealiyas, 2020).

Viral load suppression can be defined as a viral load of fewer than 1,000 copies/ml of HIV1 RNA and the patient should be enrolled in ART care and treatment at least for six months. If a patient on ART showed new or reoccurred clinical signs and symptoms with severe immunodeficiency or WHO clinical stage 4 after 6 months of initiation of treatment, the patient is diagnosed as having clinical failure (Nelson et al. (2014)). Socio-demographic, patient adherence status to ART treatment, psychological factors, having a history of treatment failure, presence of comorbidities, poor absorption of ART drugs, drug toxicity, drug abuse, having sexually transmitted disease, and knowledge of patient on the importance of viral load suppression are the main factors for viral load non-suppression (Ballesteros-Zebadúa, 2013; Boullé et al., 2016; Centers for Disease Control and Prevention, 2018; Chao et al., 2012; Flynn et al., 2017; Jorge et al., 2013; Joseph Davey et al., 2018).

The Joint United Nations Program on HIV/AIDS (UNAIDS) set achievable targets plan called 90-90-90 to end the Acquired Immune Deficiency Syndrome (AIDS) epidemic. Its plan in 2020 was; that 90% of all HIV positive patients should know their serostatus for HIV, 90% of people who are tested seropositive for HIV should start ART treatment, and 90% of all people taking ART should have suppressed viral load (UNAIDS (2017)). If this plan was implemented in 2020, it will used to end the HIV/AIDS pandemic in the world by 2030 (Baggaley et al., 2016; Ballesteros-Zebadúa, 2013). But, 84% of people who are HIV positive knew their seropositivity, 73% of them had enrolled in HIV treatment and care, and 66% of them had suppressed viral load by the end of 2020 (PEPFAR, 2019; UNAIDS, 2017; UNAIDS, 2021).

Antiretroviral treatment can reduce the risk of HIV-related complications, stop the virus from progressing, and help prevent further transmission. The availability of antiretroviral treatment was scaled up rapidly in Sub-Saharan Africa. This in turn leads to the need for monitoring and evaluation of the institution for appropriateness of the service delivery. According to the World Health Organization, viral load monitoring is the best method to assess the effects of ART treatment for HIV-positive patients (Zealiyas (2020)). It is used to improve treatment quality and individual health outcomes for people living with HIV, contribute to prevention, and potentially reduce resource needs for costly second and third-line HIV medicines by measuring the level of viral load and identifying what resources are scarce (UNAIDS (2016)). Even if different activities are implemented to decrease viral load among HIV-positive patients, viral load nonsuppression is still a problem in Ethiopia. The proportion of viral load suppression in 2020 was 72%, which is very far from the 90% target to be achieved in 2020 (90–90-90: JUNPoHA, 2014; Health. FMo, 2017). This study aims to assess the level of viral load suppression and its determinants among patients attending ART clinics in Ethiopia. This helps to evaluate the pooled magnitude of viral load suppression in Ethiopia by comparing it with the target plan set by the Joint United Nations Program on HIV/AIDS (UNAIDS). Also, determinant factors are stated to increase for low coverage of viral load suppression among HIV-positive patients in Ethiopia.

Methods

Study setting, design

A systematic review and meta-analysis were done to determine the pooled magnitude of viral load suppression and its determinants in Ethiopia. The pooled magnitude of viral load suppression was studied by meta-analysis while the determinant factors were reviewed using a systematic method. We used the Systematic Review and Meta-Analysis (PRISMA) guideline(See S1) (PTRoSRaM-A (2021)).

Search strategies and sources of information

We used databases like Google Scholar, Scopus, African Journals Online Literature, PubMed, and Web of Sciences to find eligible articles. Searching for literature started in December 2022 and ended in February 2023. We used Medical Subject Headings (MeSH) and keywords using different Boolean operators 'AND' and 'OR'. The following words/terms were used to find articles that are similar to our title for the PubMed database: – 'viral load suppression' OR 'Non suppressed viral load' AND 'associated factor' OR: 'determinants' and 'Attending ART clinic' AND 'Ethiopia'. We also

searched by writing the title itself' The magnitude and its determinants for suppressed viral load among People living with HIV AIDS in Ethiopia'

Eligibility criteria

All studies with the title of magnitude and factors associated with viral load suppression which were either published or unpublished since 2016 including pre-print studies that were written in English language only were included in the study. The restriction of time-bound is because of the routine viral load assessment started in Ethiopia in 2016. We considered all articles irrespective of the study design and age of the study population. All literature that did not contain complete ideas, especially articles that lacked the abstract part were excluded from our study. The abstract part should contain at least the dependent variable (viral load suppression) and its determinants. Also, conference papers, editorials, review papers, and letters to the editor were excluded from the study.

P:-Patient/population

- ✓ HIV-positive patients attending the ART clinic
- ✓ Both institution and community were the settings
- **I:-Intervention 'Exposure'**
- ✓ The intervention is the risk factor or exposing or precipitating factors for viral load suppression
- **O:-Outcome**
- ✓ The outcome was the status of viral load suppression among ART patient-
- **Operational definitions**
- **Primary outcome**
- ✓ Viral load suppression (Yes): If the study population has a viral load of fewer than 1000 copies/ml.
- ✓ Viral load suppression (No): If the study population has a viral load greater than 1000 copies/ml.
- **Secondary outcome:-** factors that are associated with Viral load suppression
- ✓ **Good ART adherence**:-Taking >85% a dose of ART medication within a month
- ✓ **Poor -ART adherence:-**Taking ≤85% a dose of ART medication within a month
- ✓ **HIV positive status disclosure**:-Informing one's HIV positive status to another person (sexual partner, family or friends, or others)
- ✓ **Worked:-**ART patients that could come to care and treatment unit by themselves without any support and could perform their daily activities
- ✓ **Ambulatory:-** ART patients that could come to care and treatment unit by themselves without any support but could not perform their daily activities

Data extraction

All articles obtained by searching from different engines were exported to Endnote version X8 software. Then these articles were exported to a Microsoft

Excel spreadsheet. A standardized data extraction tool was used for data extraction which incorporates the year of publication, names of the authors, study design, study setting, study region, sample size, and level of viral load suppression and its predictors [Using odds ratio with their 95% confidence interval]. Three reviewers (TM, TS, and AZ) extracted the data independently. Then they compile the extracted data. If there is any disagreement, they solve the disagreements by freely discussing and resolving and they reach a common consensus.

Quality assessment

Study quality was assessed using a standardized tool adapted from the Newcastle–Ottawa quality assessment tool for Crossectional studies which was adapted from Newcastle–Ottawa Quality Assessment Scale for cohort studies, (see S2) (Wells et al. (2000)). Three authors (TM, TS, and AZ) assessed the quality of the tool by assessing the representativeness of the sample, on respondent rate, determining adequate sample size, and ascertainment of exposure variable. Those articles that fulfilled the required criteria were scored value 1 while those which did not fulfill the criteria were scored 0 and considered as having poor quality. No article was excluded from the review because of poor quality. See individual scores for each article (S3).

Data processing and analysis

Articles searched using different search engines were imported into Endnote Version 6 software and duplicates were removed. Data were recorded in abstraction forms and entered into Stata 14 software for analysis.

Systematic review and meta-analysis were conducted by using STATA 14 software. We pooled the estimate of the total prevalence of viral load suppression using a random effect model. The overall pooled magnitude of viral load suppression with 95% confidence among HIV-positive patients attending ART clinics in Ethiopia was reported using a forest plot. Cochran statistics and I2 statistics were used to assess the heterogeneity of the study. The level of statistical heterogeneity between studies was assessed using I2 statistics and values of 25, 50, and 75% were considered to represent low medium, and high, respectively. The random-effects model was used for the data identified as heterogeneous during analysis. We performed meta-regression analyses to find the most likely cause of heterogeneity using Stata version 14 statistical software. A funnel plot was used to detect the presence of publication bias.

Subgroup analysis based on research locations (regions of Ethiopia) was done to further pinpoint the potential cause of heterogeneity across the studies. The presence of significant publication bias was measured using

the funnel plot and Egger's regression tests (p-value < 0.05 was considered to be suggestive of statistically significant publication bias).

Results

Search results and characteristics of included studies

A total of 310 potential studies were found using different search engines, 145 from PubMed engine, 163 from Google Scholar, and 2 were searched by cross reference. Twelve articles that fulfilled the eligibility criteria were included in a systematic and meta-analysis study. We extracted full-text screening after checking the abstract for eligibility (Figure 1)

The prevalence and determinant of viral load suppression among HIV-positive patients were estimated using these twelve studies which were published in different parts of Ethiopia. The total number of study participants from these 12 (two of them were unpublished) articles was 10,202. The minimum sample size was 194 (Dires (2021)) while the maximum sample size was 503 (Zealiyas (2020)). The highest and lowest level of suppressed viral load were in Oromiya and Amhara region, which was 10% and 92% respectively (Mehari et al., 2021; Waju et al., 2021) See (Table 1).

The magnitude of viral load suppression in Ethiopia

The pooled prevalence of viral load suppression was plotted using a forest plot. The pooled prevalence of viral load suppression among ART patients attending ART clinics in Ethiopia was 75.25% (95% CI: 68.61–81.89) with $I^2 = 98.3\%$, $p \leq 0.001$ (Figure 2).

Subgroup analysis by study region was done. The sub-group analysis showed that the Oromiya region has the highest level of viral load suppression 85.84% (95% CI: 79.75–91.93). However, the Southern Nation Nationalists and People (SNNP) region has the lowest viral load suppression 71.06% (95% CI: 65.68–76.44) (Figure 3).

Publication bias

A funnel plot test was used to assess if there is publication bias. There was no substantial publication bias as demonstrated by the Begg rank correlation test ($p = 0.371$). The Egger weighted regression, which was used in this systematic review and meta-analysis to test for publication bias, also revealed that there is no significant amount of publication bias (no- small-study effect) for the pooled estimate of viral load suppression in Ethiopia ($P = 0.161$; 95% CI: −.147 to .747). However, a funnel plot test, which was used to check for asymmetry distribution of viral load suppression by visual inspection, asymmetrical

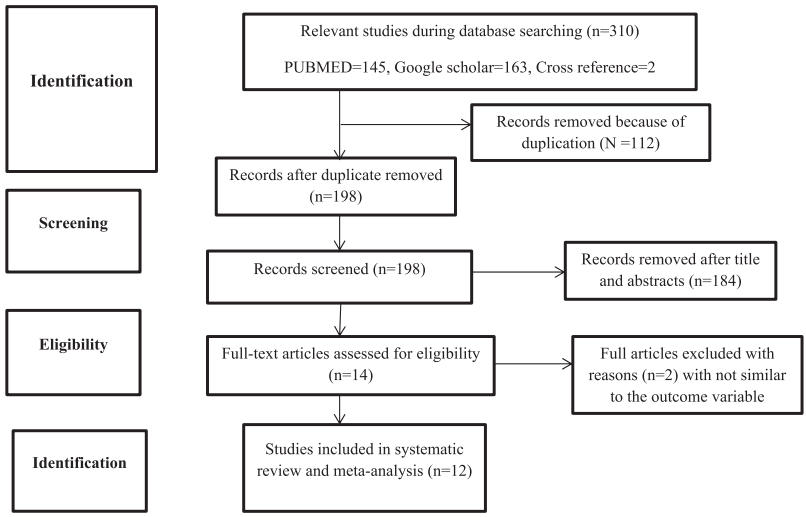

Figure 1. PRISMA flow diagram for the studies screened, reviewed, and included for the study of viral load suppression in Ethiopia, 2023

distribution in this study is evidence of publication bias because it shows that each point in funnel plots represents a separate study (Figure 4).

Meta-regression analysis

In addition to subgroup analysis, Meta-regression analysis was done to find out sources of heterogeneity using a meta-regression model using the year of publication and sample size. However, the meta-regression analysis showed that both of them were not statistically significant for heterogeneity of viral load suppression among ART patients in Ethiopia.

Sensitivity analysis

Sensitivity analysis was done to assess if only a single study influenced the overall magnitude of viral load suppression using a random effect model. The sensitivity analysis showed the studies were not affected by a single study for the study of the prevalence of viral load suppression in Ethiopia (Figure 5).

Determinants of viral load suppression

In this study, poor adherence, baseline CD4 count, and being female were determinants of pooled estimates of viral load suppression in Ethiopia (See Figures 6–8).

The study population who had good ART adherence had 2.7 more likely suppressed viral loads compared to those who had poor ART adherence (AOR: 2.7; 95% CI: 2.3, 3.2). The study population that had a baseline CD4 count of greater than or equal to 350 cells/mm3 had 1.7 more likely

Table 1. Characteristics of articles for the study of predictors of viral load suppression among HIV-positive patients in Ethiopia.

Author, publ. year	Study design	Study region	Study population	Study setting	Sample size	*P* in (%)	Determinant factors (OR, 95%CI)	Study quality
Getachew D. et al. 2021 (Getachew et al. (2021))	Crossectional	A.A	Adult and children	Institution based	287		Functional status of the patient (0.22; 0.10, 0.35), adherence (0.65; 0.44, 0.87), smoking (0.16, 0.05, 0.03)	8
Muche Yilkal, unpublished (Dires (2021))	Case-control	A.A	Adult and children	Institution based	194		Depression (5; 1.7–14.60), WHO Stage(3.11; 1.60, 6.20), Adherence (10.9; 2.40, 21.40)	7
Kidst Zealias, 2020 (Zealiyas (2020))	Crossectional	A.A	Adult and children	institution	5038	52.4	Adherence(1.5; 1.20, 1.80) and clinical stage(2.50; 2.1, 2.90)	8
Getaneh Y. et al. unpublished (Getaneh et al. (2019))	Retrospective cohort	A.A	Children	Institution based	554	42.5	Family HIV disclosure status (.91;.06-0.90) being orphan (0.51; 0.25–4.47), duration of ART (1.86; 1.41, 3.31), CD4 count (1.02; 1.46, 1.90), WHO stage (1.58; 1.42, 3.12)	9
Dires G et al. 2020 (Diress et al. (2020))	Retrospective cohort	Amhara	Adult and children	Institution based	235	53.0	Being females (1.2; 1.02–1.19) and having higher educational status (1.70; 1.25–2.16), duration on ART (0.35; 0.13–0.95), and having baseline viral load count >10,000 copies (0.44; 0.28–0.71).	8
Terefe G et al. 2022 (Atnafu et al. 2022)	Retrospective cohort	Amhara	Adult and children	Institution based	346	25.1	Being female (1.50; 1.05–2.10), baseline CD4 count $\geq$ 350 cells/mm3 (1.98; 1.12–3.51) and no recurrent OI (1.85; 1.06–3.24)	9
Balew M. et al. 2019 (Shiferaw et al. (2019))	cross-sectional	Amhara	Adult	Institution based	1576	26.1	Nevirapine vs. efavirenz (1.90; 1.41–2.56), routine testing of viral load 1.38 (1.03–1.84)	8
Hassen A. et al. 2019 (Ali and Yirtaw (2019))	Retrospective cohort	Oromiya	Adult	Institution based	247	10	Marital status; p value = 0.023 and CD4 < 200 count (p value = 0.023)	7
Abetu E. et al. 2021 (Mehari et al. (2021))	Retrospective cohort	Oromiya	Adult	Institution based	359	30.9	Good Adherence (6.2; 1.93, 20.11), overall duration on ART (A1.02,1.01, 1.04)	8
Waju B. et al. 2021 (Waju et al., 2021)	Retrospective cohort	Oromiya	Adult and children	Institution based	669	72.3	Duration <2 years (0.09; 0.01–0.83), lower baseline BMI (4.44; 1.56–12.64), lower baseline CD4 (2.76, 1.45–5.29), poor adherence to ART medication (3.19; 1.29–7.89), and immunological failure (4.26; 2.56–7.09)	8
Haile T, et al. 2021 (Haile et al. (2021))	Retrospective cohort	Oromiya	Adult and children	Institution based	424	52.1	-Routine viral load testing (0.01; 0.001, 0.02), and being on 2nd line Art (8.98; 2.64, 30.58) Nevarapine based RX (0.02; 0.01, 0.23)	8
Assegu D et al, 2021 (Fenta et al. (2021))	Retrospective cohort	SNNP	children	Institution based	273	53.7	Being rural residence(4:91; 1.28–8.82), sex (1.90; 1.04–3.48)	9

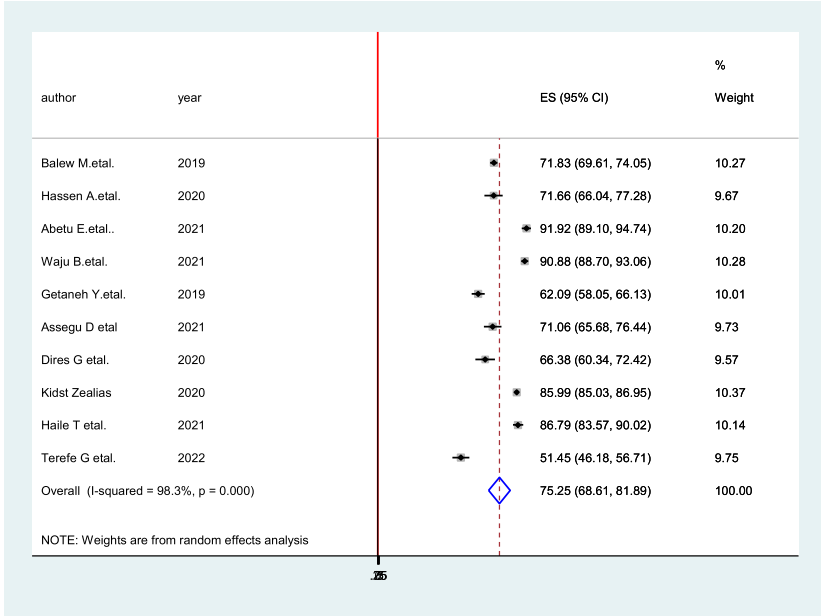

Figure 2. Forest plot for the study of pooled magnitude of viral load suppression among HIV-positive patients attending ART clinics of Ethiopia, 2023.

suppressed viral loads than those who had a baseline CD4 count of 200 cells/mm3 (AOR: 1.7; 95% CI: 1.5, 1.9). A female was 1.4 times more likely to have suppressed viral loads than males (AOR = 1.4, 1.1–1.8).

Discussion

This study assessed the pooled magnitude and its determinant for viral load suppression among seropositive HIV tests among patients attending ART clinics in Ethiopia. The pooled level of viral load suppression among patients attending ART clinics in Ethiopia is 75%. This result is lower than the goals supported by plans to be achieved in 2020 by UNAIDS which was 90% (UNAIDS JUNPoHA (2019)). Also, it is lower than the study conducted in Uganda which is 94% (Nabitaka et al. (2020)), Haiti (85%) (Jean Louis et al. (2018)), and Swaziland (82%) (Jobanputra et al. (2015)). But, this study is higher than the study conducted in Brazil which is (62%) (Bello et al. (2008)), Malawi 34% (Huibers et al. (2018)), Tanzania (25%) (Muri et al. (2017)), and Mali (61%) (Germanaud et al. (2009)). The justification might be because of differences in quality and number of availability of health professionals, availability of health services, and availability of transport systems to the ART centers.

Subgroup analysis by study region was done. The sub-group analysis showed that the Oromiya region has the highest level of viral load

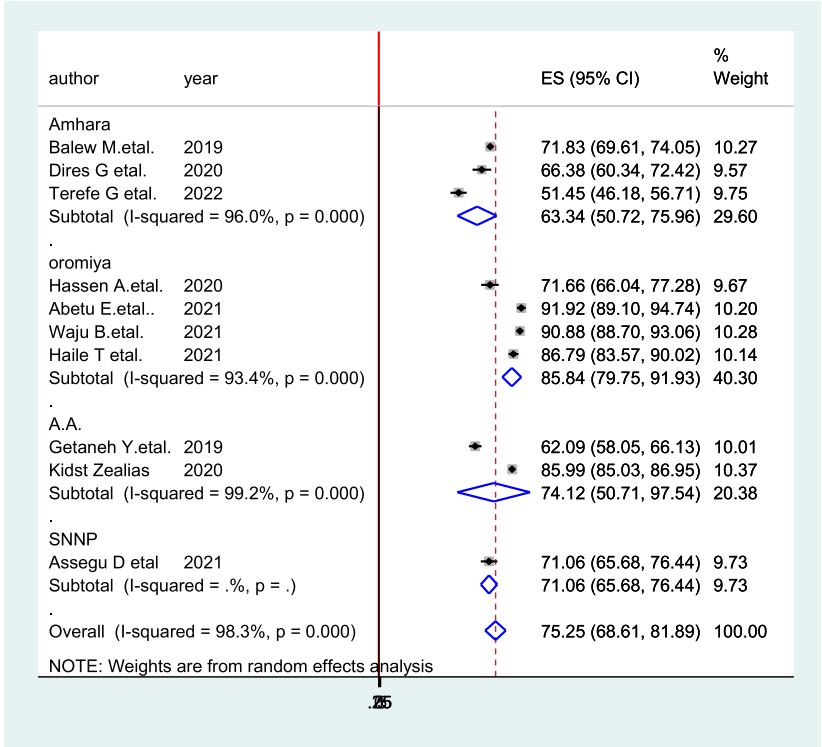

Figure 3. Subgroup analysis by the region for the study of the pooled magnitude of viral load suppression among HIV-positive patients attending ART clinics of Ethiopia, 2023.

suppression 85.84% (95% CI: 79.75–91.93). However, the Southern Nation Nationalists and People (SNNP) region has the lowest viral load suppression 71.06% (95% CI: 65.68–76.44). This difference might be because only one primary study was included in the Southern Nation Nationalists and People (SNNP) region.

This study showed that ART adherence is a determinant factor for viral load suppression. Those study participants who had good ART adherence were more likely to have suppressed viral load than those who had poor ART adherence. This study is consistent with the study conducted in Thailand, Vietnam, and Uganda (Anude et al., 2013; Chao et al., 2012; Church et al., 2008; Das et al., 2010; Hailemariam et al., 2013; Jobanputra et al., 2015; Meireles et al., 2018; Moolasart et al., 2018; Rangarajan et al., 2016; Sabaté, 2003). The possible justification might be because adherence enhances patients to take their drugs at appropriate times and doses. They followed strictly the counseling, advice, and any recommendations given by health care workers. Having poor adherence might lead to non-suppression of viral load which in turn leads to opportunistic infections, drug resistance, and finally mortality (Arrivillaga et al. (2013)).

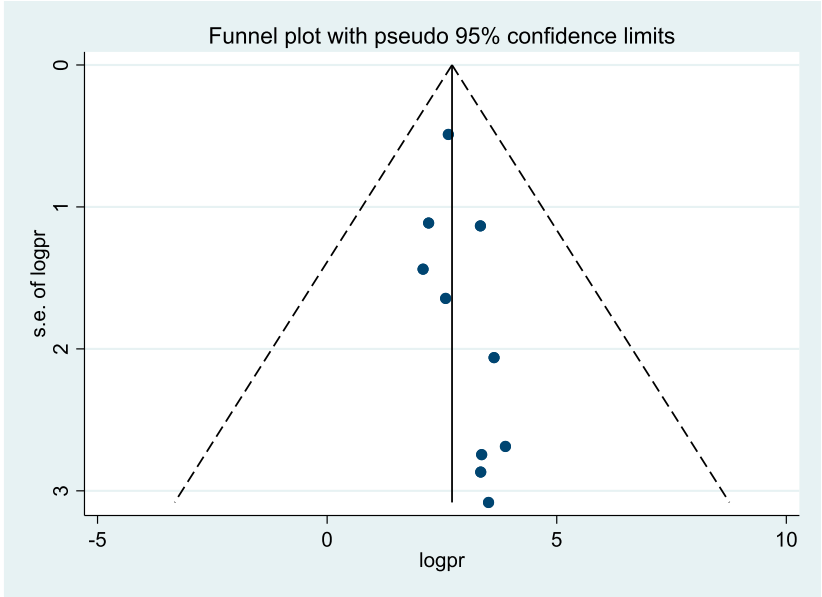

Figure 4. Funnel plot test for the magnitude of viral load suppression among HIV-positive patients attending ART clinics of Ethiopia, 2023.

This study assessed that baseline CD4 count significantly affects viral load suppression. Having a baseline CD4 count ≥350 cells/mm3 had better suppressed viral load compared to having a baseline CD4 count of fewer than 200 cells/mm3. This finding is consistent with the study conducted in Zimbabwe and Swaziland (Hicham et al., 2019; Jobanputra et al., 2015). This is because CD4 is the prime target for HIV/AIDS. If the number of HIV RNA (viral load) is high, they attack T lymphocyte cells (CD4 cells) which in turn increases the number of viruses in the blood by decreasing CD4 count. This results in higher morbidity, higher risk of opportunity infections, drug interactions, drug toxicity, polypharmacy, and suboptimal ART adherence.

Being female was significantly associated with viral load suppression. This finding is consistent with studies conducted in Ethiopia, and Uganda (Diress et al., 2020; Kipp et al., 2010). This might be due to males have lower CD4 counts compared to females. The low CD4 count might expose males to higher viral load replication than females. Also, it might be due to females being more adherent to ART treatment than males because females get different additional support services like PMTCT (MoHo, 2019; WHO, 2016).

A study conducted in rural South Africa showed that better viral load suppression can be achieved with protease inhibitors (PI) than Integrase inhibitor-based regimens and NNRTI (Schoffelen et al. (2013)). A study conducted in Ethiopia revealed that a second-line ART regimen was significantly associated with Virological non-suppression (Haile et al. (2021)). Second-line

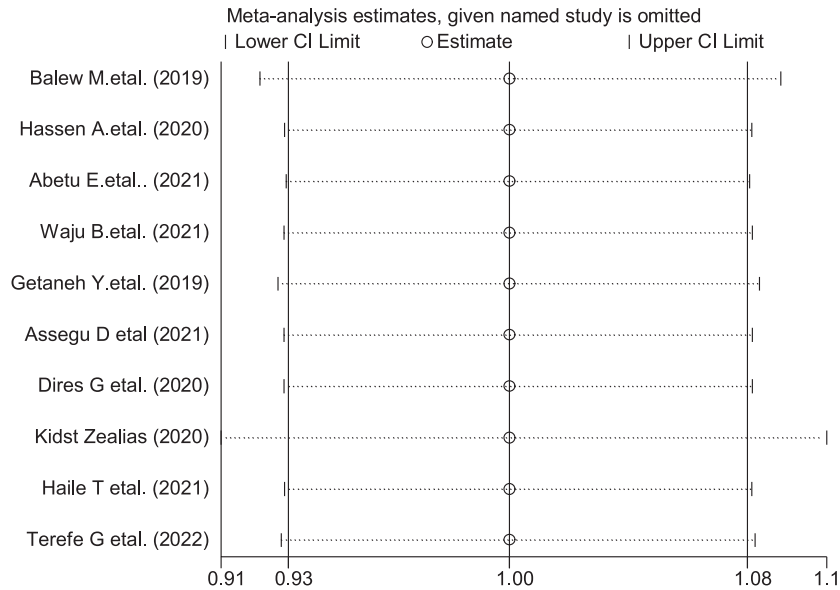

Figure 5. Sensitivity analysis for the study of the pooled magnitude of viral load suppression among HIV-positive patients attending ART clinics of Ethiopia, 2023.

treatment is becoming increasingly difficult to achieve viral suppression. This may be because other program and client-related factors may impact virological suppression (Bulage et al., 2017; Edessa et al., 2019; Sylla et al., 2019). Nonsuppression of viral load has critical implications in resource-limited settings; including sub-Saharan Africa (Edessa et al. (2019)). When deciding on

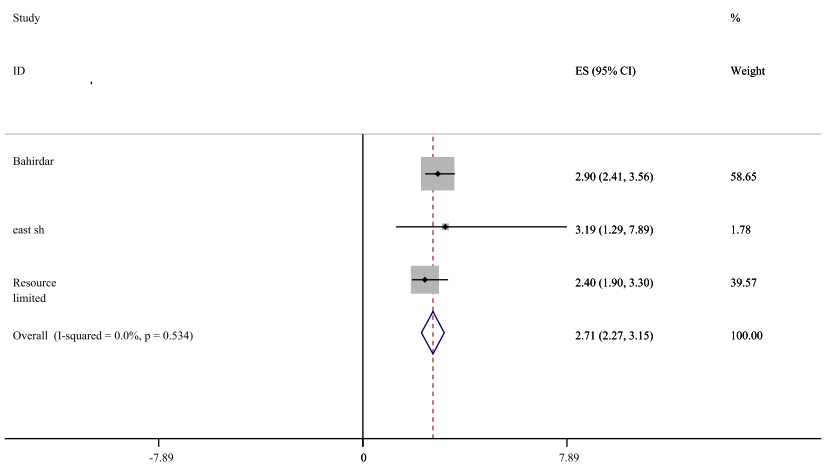

Figure 6. Forest plot for adherence as a determinant factor for pooled magnitude of viral load suppression among HIV-positive patients attending ART clinics of Ethiopia, 2023.

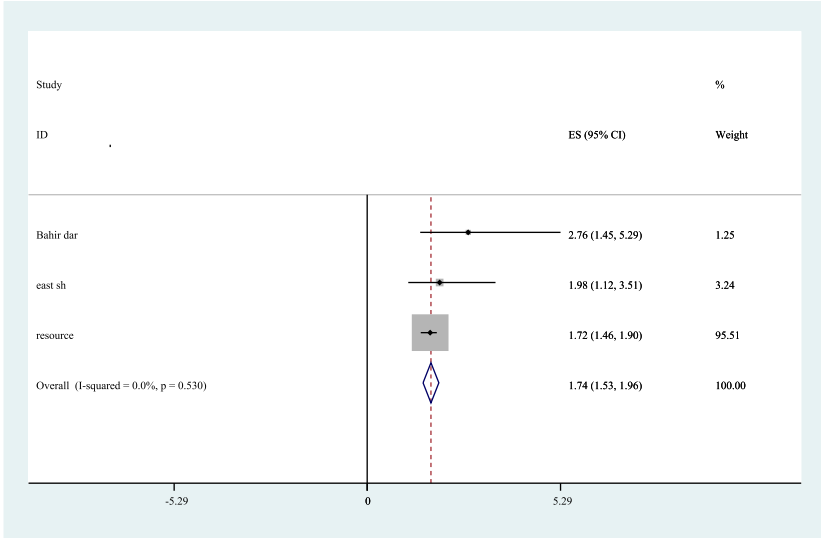

Figure 7. Forest plot for Cd4 for pooled magnitude of viral load suppression among HIV positive patients attending ART clinics of Ethiopia, 2023.

the next course of treatment for patients on a second-line regimen who do not exhibit virological suppression, special consideration should be given (Sylla et al. (2019)). Therefore, monitoring the level of HIV viral load in individuals living with HIV is essential to maintain effective individual antiretroviral therapy (Drain et al. (2019)).

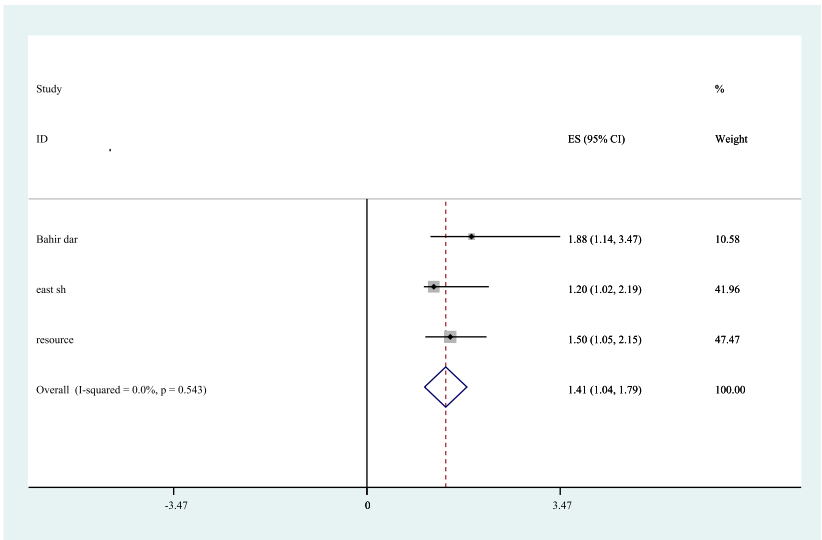

Figure 8. Forest plot for Sex as a determinant factor for pooled magnitude of viral load suppression among HIV positive patients attending ART clinics of Ethiopia, 2023.

Strengths and limitations of the study

✓ We used PRISMA guidelines.
✓ As a limitation, the study might lack generalizability because no articles were found from regions like (Tigray, Gambela, Afar region, and Somali)
✓ Even if routine viral load assessment was initiated in 2016 in Ethiopia, almost all of the included studies were in 2020 and later.
✓ Some of the studies are retrospective study designs which might lack some important variables. Variables like the effect of the type of ART drugs on viral load suppression were missed.

Conclusion

The pooled prevalence of suppressed viral load was 75% which is lower than the planned level by the Sustainable Development Goal (SDG) 2020, which was 90%. Having good adherence, baseline CD4 count, and being female were determinants of suppressed viral load. Therefore, the stakeholders should be focused on the existing strategies to decrease viral load among ART patients. They should work to adhere to patients for ART treatment. Also, early diagnosis and initiating ART for increasing CD4 count should be strengthened. Patients should receive frequent monitoring and intensive adherence counseling by health professionals about viral load suppression. Going forward, the effects of different types of ART drugs on viral load suppression should be studied.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Ethics approval

Ethics approval Ethical approval was not required because the data of this study were retrieved and synthesized from already published studies.

Data availability statement

Data availability statement will be available on reasonable request.

Authorship

TM, TS, KH, AT, AZ, YW, KZ, and JB have substantial contributions to the conception, design, and acquisition of data, analysis, and interpretation of data. TMB drafted the article and revised it critically for important intellectual content. All authors have approved the final version of this manuscript.

S1. Prisma checklist for the study of viral load suppression among HIV-positive patients

S2. Newcastle – Ottawa Quality Assessment Scale for Cohort Studies

S3. Quality assessment score for individual items for the study of viral load suppression among HIV-positive patients

Notes on contributors

Tamirat Melis is currently working as lecturer at Department of Public Health, College of Medicine and Health Science, Wolkite University, Ethiopia. He provides epidemiology and biostatistics courses for undergraduate and master students. He is also interested and is doing research and community projects which solve problem of the community.

Tadesse Sahle is currently working as lecturer at Department of Nursing, College of Medicine and Health Science, Wolkite University, Ethiopia. His interest is conducting research in nursing procedures.

Kassahun Haile is currently lecturer of Wolkite University Department of medical laboratory, College of Medicine and Health Science, Wolkite University, Ethiopia. His interest is conducting research and attending PhD program to upgrade his profession.

Abebe Timerga is currently working as head of preclinical medicine, College of Medicine and Health Science, Wolkite University, Ethiopia. His interest is conducting research which is related to biochemistry.

Amare Zewdie is currently working as lecturer at Department of Public Health, College of Medicine and Health Science, Wolkite University, Ethiopia. His interest is solving community health problem and providing health education using different model.

Yohannes Wegu Kule Refugee Camp, Gambela health offices, Southwest Ethiopia. His interest is implementation of different policy and guidelines which are prepared by ministry of health of Ethiopia.

Kebebush Zepire is currently working as lecturer at Department of Public Health, College of Medicine and Health Science, Wolkite University, Ethiopia. Her interest is conducting research on health service management.

Jemal Bedewi is currently working as lecturer at Department of Public Health, College of Medicine and Health Science, Wolkite University, Ethiopia. His primary focus is identifying and implementing strategies to ensure the wellbeing of the environment.

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