Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Impact of antiretroviral (ARV) stock-outs and regimen substitutions on clinical outcomes among people living with HIV in Libya: a mixed-methods study

Sara Alferjani
University of Tripoli
Mohamed HADi Mohamed Abdelhamid
m.abdelhamid@ncdc.gov.ly
Libyan biotechnology research Center
Amal Benkorah
University of Tripoli

Research Article

Keywords: HIV, antiretroviral stock-outs, viral load suppression, adherence, co-infection, digital health, Libya

Posted Date: April 21st, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9451632/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background:

Antiretroviral stock-outs in conflict-affected regions like Libya disrupt essential HIV treatment, risking viral suppression and health outcomes. However, the specific clinical impact of these interruptions remains critically under-researched.

Methods:

A mixed-methods study at Tripoli Central Hospital included a review of 230 HIV patient records and questionnaires from 16 healthcare workers. The retrospective analysis examined ART outcomes like viral load suppression and CD4 changes (per WHO/UNAIDS guidelines), using multivariable regression to find factors linked to poor results. The cross-sectional part assessed staff experiences with ARV stock-outs.

Results:

The study of 230 participants (96.5% living with HIV) provides a comprehensive analysis of the clinical impact of antiretroviral (ARV) stock-outs in Libya. The cohort was predominantly male (66.1%) with a mean age of 42.3 years. Among 219 patients on chronic ART, 51.1% experienced regimen modifications, with 85% of these shifts necessitated by drug unavailability.

The clinical outcomes for those on stable regimens were significantly superior, achieving 75% viral suppression and higher mean CD4 counts (450 cells/μL) compared to 45% suppression and 250 cells/μL in patients with multiple regimen changes ($p < 0.01$). Notably, 92% of patients experiencing disruptions remained engaged in care. Additionally, the study confirmed the efficacy of sofosbuvir/daclatasvir for HIV/HCV co-infections and the success of prophylactic protocols in preventing new HIV transmissions.

Conclusion:

ARV stock-outs and forced regimen substitutions are associated with adverse HIV treatment outcomes in Libya. Strengthening ARV supply chain resilience, expanding clinical pharmacy services, and integrating digital health systems are critical to improving treatment continuity and optimizing patient outcomes in conflict-affected settings.

Key Points

- Impact of Stock-outs: Antiretroviral stock-outs were the primary driver of treatment modifications, affecting over half of the patients and significantly undermining clinical outcomes.
- Clinical Disparities: Patients maintained on stable regimen achieved significantly higher viral suppression and better immunological recovery compared to those experiencing frequent regimen changes.

- Resilience in Care: Despite widespread drug availability issues, most patients remained actively engaged in care, suggesting that intensified clinical monitoring can effectively mitigate the negative impact of treatment interruptions.

Introduction

Sustained access to antiretroviral therapy (ART) is the cornerstone of effective HIV care and a prerequisite for achieving viral suppression, preventing disease progression, and reducing HIV transmission (1). Over the past three decades, advances in antiretroviral (ARV) medicines have transformed HIV from a fatal illness into a manageable chronic condition, provided that uninterrupted treatment is maintained (2). Global initiatives led by the World Health Organization (WHO) and the Joint United Nations Programme on HIV/AIDS (UNAIDS), including the 95–95–95 targets, emphasize the centrality of treatment continuity in controlling the HIV epidemic (3). Nevertheless, in many low- and middle-income countries (LMICs), persistent disruptions in ARV supply chains continue to undermine these gains (4).

In fact, ARV stock-outs remain a widespread challenge in resource-limited and conflict-affected settings, where weak procurement systems, fragmented supply chains, reliance on external funding, and political instability compromise medicine availability (5, 6). Interruptions in ART have been consistently associated with poor adherence, viral rebound, increased risk of opportunistic infections, and the emergence of antiretroviral drug resistance (7–9). Moreover, to mitigate stock-outs, healthcare providers often resort to regimen substitutions or temporary treatment modifications, practices that may deviate from international treatment guidelines and potentially compromise long-term clinical outcomes (10). Despite their frequency, the clinical consequences of such coping strategies remain underexplored, particularly in fragile health systems. Evidence from HIV programmes in sub-Saharan Africa has highlighted that stock-outs of essential HIV commodities are often driven by systemic weaknesses in procurement, forecasting, and supply chain management (5, 6).

In conflict settings, disruptions in ARV supply are often exacerbated by insecurity and health facility closures, leading to frequent regimen changes and treatment interruptions (10). Armed conflict further disrupts HIV service delivery by damaging health systems, interrupting treatment continuity, and increasing the risk of poor clinical outcomes (11). In the same vein, conflict has long-term consequences on health systems, weakening infrastructure and undermining service delivery capacity (12).

In the same vein, the Middle East and North Africa (MENA) regions have one of the lowest ART coverage rates globally (3, 13), driven by a combination of stigma, underdiagnosis, and health system constraints. In Libya, these challenges are further compounded by prolonged political instability, economic disruption, and fragmentation of healthcare governance (14). Since 2011, repeated disruptions to national procurement mechanisms and medicine distribution networks have resulted in recurrent ARV stock-outs across major HIV treatment centers (15). These disruptions threaten treatment continuity and place

additional burdens on healthcare workers who must manage patients under suboptimal clinical conditions.

HIV care in Libya is delivered through a limited number of specialized centers, creating geographic and structural barriers to access (14, 15). Persistent stigma and confidentiality concerns have contributed to substantial patient migration toward major HIV treatment facilities in Tripoli, particularly Tripoli Central Hospital and Tripoli University Hospital, which function as key referral centers for HIV care (16). Furthermore, this concentration of patients, combined with inconsistent ARV availability and limited laboratory capacity for viral load and resistance testing, has intensified the complexity of clinical decision-making. In practice, clinicians and pharmacists are frequently required to implement alternative ARV regimens during stock-out periods, often without adequate clinical pharmacy support or real-time supply chain data.

While regional and international reports have documented the occurrence of ARV stock-outs in Libya (15, 17), there is a notable lack of empirical research assessing their direct impact on patient-level clinical outcomes. In particular, evidence is scarce regarding how treatment interruptions and regimen substitutions affect viral suppression, immunological recovery, and adherence in real-world clinical settings. Moreover, limited attention has been given to the experiences of healthcare workers managing ARV shortages and the systemic factors—such as fragmented health information systems and the absence of integrated digital supply chain tools—that exacerbate these challenges.

This study addresses these gaps by examining the impact of ARV stock-outs and the use of alternative treatment regimens on clinical outcomes among people living with HIV receiving care at Tripoli Central Hospital, a major referral center for HIV care in Libya. By integrating retrospective patient-level clinical data with insights from healthcare providers, this research aims to generate context-specific evidence on the consequences of treatment disruptions in a conflict-affected setting. The findings seek to inform strategies for strengthening ARV supply chain resilience, optimizing treatment decision-making, and supporting the integration of digital health solutions to improve continuity of HIV care in Libya and similar settings.

Methods

Study design and setting

A mixed-methods study was conducted at the Infectious Diseases Department of Tripoli Central Hospital, Libya, a major referral center for HIV care receiving patients from multiple regions of the country. The study combined (i) a retrospective observational component using routinely collected clinical records to assess the impact of antiretroviral (ARV) stock-outs and regimen changes on patient outcomes, and (ii) a cross-sectional component using a semi-structured questionnaire to capture healthcare workers' experiences and coping strategies during stock-out periods.

Study population and eligibility

Patient cohort

The retrospective cohort included people living with HIV receiving care at Tripoli Central Hospital between January 2021 and December 2023. Eligible records included adults (including pregnant women and patients with documented co-infections such as TB, HBV, and HCV) with documentation of ART exposure and at least one recorded viral load (VL) and/or CD4 measurement, particularly where ARV stock-outs or regimen switches occurred during the study period. Records with substantial missing or incomplete information were excluded.

Healthcare workers

A total of 16 healthcare workers (clinicians and pharmacists) directly involved in HIV care at Tripoli Central Hospital participated in the questionnaire component.

Data sources and data collection

Retrospective data were extracted using a standardized data extraction checklist. Patient information was obtained from both paper-based medical records and available electronic systems. Because documentation was fragmented across sources, extracted variables were cross-validated against multiple datasets, including electronic Patient Information System (PIS) entries, pharmacy-maintained Excel sheets, and relevant specialist registries (e.g., TB, HBV, HCV, and prophylaxis registries). Viral load results were occasionally recorded only in unstructured clinician notes and were manually verified when necessary. Treatment adherence was assessed using pharmacy dispensing records alongside PIS and paper chart documentation. ARV stock-out periods were verified through hospital pharmacy records.

For the healthcare worker component, a semi-structured questionnaire was developed following a review of relevant literature on HIV programme implementation and antiretroviral (ARV) stock-outs and informed by the Knowledge–Attitudes–Practices (KAP) survey framework and World Health Organization (WHO) guidance on HIV treatment and programme management (18, 19). The questionnaire was designed to capture knowledge, perceptions, and practices related to ARV stock-out management in routine clinical settings. The instrument included both closed-ended items for descriptive quantification and open-ended questions to explore perceived causes, coping strategies, and system-level barriers during stock-out periods. The questionnaire was reviewed by subject-matter experts to ensure content validity and was pilot-tested prior to administration, with feedback used to refine clarity and reduce redundancy.

Variables and outcomes

Key variables extracted included demographic characteristics, clinical history (including co-infections), ART regimen history, frequency and reasons for regimen changes, adherence indicators, and laboratory outcomes.

Primary outcomes were viral load suppression and change in CD4 cell count over the observation period. Viral load suppression was defined as a plasma HIV-1 RNA level of < 1,000 copies/mL, in accordance with World Health Organization and UNAIDS guidelines (15). Where available, lower thresholds (< 200 or < 50 copies/mL) were also examined to describe optimal virological control.

Secondary outcomes included treatment adherence indicators and the frequency of ART regimen changes. Because routine genotypic drug resistance testing was limited, indirect indicators—such as repeated regimen switches and clinical treatment failure—were used to describe the potential risk of drug resistance.

Statistical analysis

Data were coded and entered into Microsoft Excel, then analyzed using SPSS (version 25). Descriptive statistics were used to summarize participant characteristics, ARV stock-out–related regimen changes, and clinical outcomes. Comparative analyses (e.g., chi-square tests and t-tests) assessed differences in outcomes between patients experiencing multiple regimen changes versus those maintained on stable regimens. Multivariable regression models were used to identify factors associated with poor clinical outcomes. Qualitative responses from healthcare workers were analyzed using thematic analysis to identify recurrent themes related to stock-out management challenges and coping strategies.

Ethical considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (1964) and its subsequent amendments. Ethical approval was obtained from the University of Tripoli and the Libyan National Committee for Biosafety and Bioethics. Additional permissions were granted by the National Center for Disease Control to access relevant programmatic and statistical information. Authorization to conduct the study was also obtained from Tripoli Central Hospital and the Infectious Diseases Department.

Results

Participant characteristics

A total of 230 individuals were included in the study dataset. Of these, 222 (96.5%) were people living with HIV receiving long-term ART, while eight (3.5%) HIV-negative individuals received antiretroviral prophylaxis (seven on pre-exposure prophylaxis and one on post-exposure prophylaxis). For analyses related to chronic HIV management and treatment continuity, 219 patients were included after excluding individuals on short-term prophylactic regimens and those not yet initiated on ART.

The majority of patients were male (66.1%), with a mean age of 42.3 years (SD: 10.4; range: 18–73 years). Nearly all participants were Libyan nationals (99.6%). Most patients originated from Tripoli (79.6%), with smaller proportions from other regions, reflecting substantial patient migration toward major HIV treatment facilities in the capital. Social status varied, with single individuals representing the largest group, followed by married patients and those with undocumented social status.

Medical history, co-infection, and prevention status

Co-infections identified among people living with HIV included tuberculosis (TB), hepatitis C virus (HCV), and hepatitis B virus (HBV). A total of 17 HIV/TB co-infected cases were identified, of which 15 patients were successfully treated, one patient died during active TB treatment, and one was lost to follow-up. Seventeen patients with HIV/HCV co-infection were successfully treated and cured using a three-month regimen of sofosbuvir and daclatasvir. Additionally, four HIV/HBV co-infected patients maintained stable clinical conditions throughout the observation period.

Regarding preventive measures, seven HIV-negative individuals (spouses of HIV-positive patients) received pre-exposure prophylaxis (PrEP) while planning conception and remained HIV-negative. One individual exposed to HIV through a needle-stick injury received post-exposure prophylaxis (PEP) and tested negative.

Treatment outcomes varied by social status, with married patients demonstrating higher adherence, while single patients showed higher TB cure rates. HCV cure and HBV stability were consistent across social groups.

Frequency and causes of ARV stock-outs

Among the 219 patients included in the chronic ART analysis, 112 (51.1%) experienced at least one ART regimen change during the study period. ARV stock-outs were the predominant cause of regimen modification, accounting for approximately 85% of all changes. Other reasons included patient-related adherence issues, drug toxicity or adverse effects, treatment failure, and one confirmed case of genotypic drug resistance (Fig. 1).

ARV stock-outs varied in duration and frequently resulted in forced treatment substitutions. Four pregnant women required ART regimen changes due to drug unavailability; however, continuous treatment was maintained throughout pregnancy, primarily using dolutegravir-based regimens, and all subsequently delivered HIV-negative infants.

Alternative ARV regimen

During stock-out periods, alternative regimens were commonly prescribed. The most frequently used substitutions included tenofovir–lamivudine–dolutegravir (TDF/3TC/DTG) and tenofovir–emtricitabine–efavirenz (TDF/FTC/EFV). Most patients (73%) experienced a single ART regimen change, while those with two or more changes were predominantly affected by recurrent ARV stock-outs (Fig. 2).

Clinical outcomes and adherence

Patients who maintained stable ART regimens demonstrated better virological and immunological outcomes compared with those experiencing multiple regimen changes. Patients on stable regimens achieved significantly higher rates of viral load suppression (75%) than those with multiple regimen changes (45%) ($p < 0.01$), and had substantially higher mean CD4 cell counts (450 vs 250 cells/μL, $p < 0.01$). Multivariable analysis further identified multiple regimen changes and poor adherence as significant predictors of suboptimal clinical outcomes (Table 2, Fig. 2).

Table 1
Baseline characteristics of the study population

Characteristic	n (%)
Gender	
Male	152 (66.1)
Female	78 (33.9)
Age (years)	
Mean ± SD	42.3 ± 10.4
Nationality	
Libyan	229 (99.6)
Non-Libyan	1 (0.4)
Region of residence	
Tripoli	183 (79.6)
Western Area	27 (11.7)
Central Area	11 (4.8)
Southern Area	8 (3.5)
Eastern Area	1 (0.4)
Social status	
Divorced	13 (5.7)
Married	65 (28.3)
Single	83 (36.1)
Unknown	58 (25.2)
Widow	11 (4.8)

Table 2
Factors associated with reduced viral load suppression among people living with HIV

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)
Multiple regimen changes	2.5	1.8–3.5
Poor adherence	1.8	1.2–2.7
OR: odds ratio; CI: confidence interval. Viral load suppression defined as < 1,000 copies/mL.		

Despite treatment disruptions, 92% of patients who experienced regimen changes remained actively engaged in care and demonstrated acceptable adherence, whereas a lower proportion of patients without regimen changes showed consistent follow-up. This pattern suggests that intensified clinical monitoring during stock-out periods may partially mitigate the negative effects of treatment interruption.

Healthcare worker experiences

Healthcare workers reported frequent challenges related to ARV availability, fragmented patient records, and limited access to laboratory diagnostics, particularly viral load and resistance testing. Coping strategies included regimen substitutions, prioritization of available drugs for high-risk patients, and reliance on clinical monitoring in the absence of laboratory confirmation. Participants emphasized the need for strengthened supply chain management, improved training, and integrated digital health systems to support timely decision-making.

Discussion

This study provides empirical evidence on the clinical impact of antiretroviral (ARV) stock-outs and regimen substitutions among people living with HIV in a conflict-affected setting. More than half of patients receiving chronic ART experienced at least one regimen change during the study period, with ARV stock-outs identified as the primary driver. These disruptions were associated with poorer virological suppression and suboptimal immunological recovery, highlighting the critical importance of uninterrupted ART availability for sustaining treatment success (7–9).

Widespread conflicts in the Middle East, including Syria, Yemen, Sudan, and Libya, extend beyond the immediate loss of life and destruction of infrastructure. They divert public resources, weaken economic stability, and reduce access to essential services, including healthcare. These conditions contribute to shortages of medicines, disruptions in healthcare delivery, and reduced access to treatment. In the context of HIV care, such disruptions may lead to treatment interruptions, reduced adherence, and poorer clinical outcomes (10–12).

The observed association between multiple regimen changes and adverse clinical outcomes aligns with findings from other low- and middle-income countries, where treatment interruptions and forced substitutions have been linked to viral rebound, reduced adherence, and increased risk of treatment failure (4, 7, 8). Although alternative regimens were frequently implemented to mitigate drug shortages,

their effectiveness was generally inferior to stable, guideline-recommended regimens (6). This underscores the clinical risks associated with non-planned treatment modifications, particularly in settings where routine viral load and resistance testing are limited.

Interestingly, patients who experienced regimen changes demonstrated higher levels of engagement in care compared with those who remained on stable regimens. This finding may reflect intensified clinical follow-up during stock-out periods, as healthcare providers sought to mitigate the risks associated with treatment interruptions. While such enhanced monitoring may partially offset the negative effects of stock-outs, it does not substitute for consistent drug availability and may place additional strain on already overburdened healthcare services.

The findings also highlight the vulnerability of specific patient groups, including pregnant women, for whom uninterrupted viral suppression is essential to prevent vertical HIV transmission (1, 3). Although all pregnant women in this cohort maintained continuous treatment and delivered HIV-negative infants, this outcome depended on the availability of suitable alternative regimens and close clinical oversight. In contexts with prolonged or recurrent stock-outs, sustaining such outcomes may not be feasible, emphasizing the need for prioritization strategies and contingency planning within national HIV programs.

Co-infections, including tuberculosis, hepatitis B, and hepatitis C, may further complicate HIV treatment outcomes in this setting. Evidence from Libya has highlighted the burden of HIV co-infections, particularly HIV/HCV, among high-risk populations, emphasizing the need for integrated management approaches (20, 21).

Healthcare workers described substantial operational challenges related to fragmented medical records, limited laboratory capacity, and insufficient clinical pharmacy support. These systemic weaknesses complicated treatment decision-making and constrained the ability to optimally manage ARV shortages. The absence of integrated digital health systems, including electronic medical records and real-time logistics management tools, further limited timely identification of stock-out risks and coordinated responses. Recent evidence from Libya has also highlighted growing concerns regarding antiretroviral drug resistance, particularly in the context of treatment interruptions and suboptimal adherence (22). In this context, sustained virological non-suppression may contribute to the emergence of antiretroviral drug resistance over time, particularly in settings with limited access to routine resistance testing (9). Strengthening digital health infrastructure could play a critical role in improving forecasting, inventory tracking, and continuity of care in similar settings.

From a policy and practice perspective, the results underscore the need for resilient ARV supply chains supported by sustainable financing mechanisms and strengthened governance. Investment in clinical pharmacy services and targeted training for pharmacists and clinicians may enhance medication safety and treatment optimization during periods of constrained drug availability. Moreover, integrating digital health solutions into HIV programs could improve data-driven decision-making, reduce reliance on ad hoc coping strategies, and support progress toward global viral suppression targets.

Strengths and limitations

The mixed-methods design, integrating patient-level clinical data with healthcare worker perspectives, strengthens the validity and contextual relevance of the findings. A key strength of this study is the use of real-world clinical data from a major HIV referral center, providing a comprehensive view of both patient outcomes and system-level challenges. However, several limitations should be acknowledged. The retrospective design relied on routinely collected data, which were occasionally incomplete or fragmented. Routine genotypic drug resistance testing was limited, necessitating the use of indirect indicators to describe resistance risk. Additionally, findings from a single referral center may not be fully generalizable to all HIV care settings in Libya, although they likely reflect broader national challenges.

Conclusions

This study demonstrates that ARV stock-outs and forced regimen substitutions have measurable negative effects on HIV treatment outcomes in Libya. Addressing these challenges requires coordinated interventions to strengthen supply chain resilience, expand clinical pharmacy capacity, and integrate digital health systems into HIV care delivery. Such measures are essential to safeguard treatment continuity, optimize patient outcomes, and enhance the resilience of HIV programs in conflict-affected and resource-limited settings.

Declarations

Acknowledgments

The authors would like to thank the staff of the Infectious Diseases Department and the hospital pharmacy at Tripoli Central Hospital for facilitating data access and verification. We are particularly grateful to Dr. Ibrahim Kraza, Dr. Khaled Ibrahim, Dr. Huda Bady, and Dr. Aisha Essadiq for their professional support and valuable insights during the conduct of this study.

We also acknowledge the National Center for Disease Control for providing relevant programmatic information and thank all healthcare workers who participated in the questionnaire component of this research. Statistical support provided by Dr. Mohammad Elhenshiri is gratefully acknowledged.

Data availability statement

The data supporting the findings of this study are not publicly available due to patient confidentiality and institutional restrictions. Anonymized aggregated data may be available from the corresponding author upon reasonable request and subject to relevant ethical approvals.

Author contributions

SA conceived and designed the study, conducted data collection, performed statistical analysis, and drafted the manuscript. MA contributed to data analysis, study supervision, and critical revision of the

manuscript. AYB provided overall academic supervision, methodological guidance, and critical review of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. World Health Organization. Consolidated guidelines on HIV, viral hepatitis and STI for key populations. Geneva: WHO; 2022.
2. Deeks SG, Overbaugh J, Phillips A, Buchbinder S. HIV infection. Nat Rev Dis Primers. 2015;1:15035.
3. Joint United Nations Programme on HIV/AIDS (UNAIDS). 2025 AIDS targets: the next generation of goals for the global AIDS response. Geneva: UNAIDS; 2021.
4. Pasquet A, Messou E, Gabillard D, Minga A, Depoulosky A, Deuffic-Burban S, et al. Impact of Drug Stock-Outs on Death and Retention to Care among HIV-Infected Patients on Combination Antiretroviral Therapy in Abidjan, Côte d'Ivoire. PLoS ONE. 2010;5(10):e13414.
5. Gils T, Bossard C, Verhulst C, et al. Stockouts of HIV commodities in public health facilities in Kinshasa: Barriers to end HIV. PLoS ONE. 2018;13(1):e0191294.
6. Brennan AT, Bor J, Davies MA, Conradie F, Maskew M, Long L, et al. Tenofovir stock shortages have limited impact on clinic- and patient-level HIV treatment outcomes in public sector clinics in South Africa. Trop Med Int Health. 2017;22(2):241–51.
7. Damulak PP, Ismail S, Abdul Manaf R, Mohd Said S, Agbaji O. Interventions to Improve Adherence to Antiretroviral Therapy (ART) in Sub-Saharan Africa: An Updated Systematic Review. Int J Environ Res Public Health. 2021;18(5):2477.
8. Piran CMG, Mori MM, Cargnin AVE, da Fonseca BS, Shibukawa BMC, Merino M, de FGL, et al. Social determinants of adherence to antiretroviral therapy among adolescents and young people living with HIV: a scoping review. Rev esc enferm USP. 2025;59:e20250026.
9. World Health Organization. HIV drug resistance report 2019. Geneva: WHO; 2019.
10. Mohammed MFN, Puteh SEW. HIV Treatment and Care Services in Yemen: Implications Of Internal Country Conflicts. Open AIDS J. 2022;16:e187461362210140.
11. Levy BS, Sidel VW. Documenting the Effects of Armed Conflict on Population Health. Annu Rev Public Health. 2016;37:205–18.
12. Palmer M, Nguyen C, Mitra S, Mont D, Groce N. The long-term impact of war on health. HiCN Working Paper 216; 2016.

13. Hamidi A, Regmi PR, van Teijlingen E. HIV Epidemic in Libya: Identifying Gaps. J Int Assoc Provid AIDS Care. 2021;20:23259582211053964.
14. World Health Organization. Health System Profile: Libya. Cairo: WHO Regional Office for the Eastern Mediterranean; 2007.
15. National Center for Disease Control (Libya). HIV surveillance and programme reports. Tripoli: NCDC; 2022.
16. Elamouri F, Rockstroh JK, Kratoo W, Miyahara Y, Pumpaibool T. HIV/AIDS knowledge and attitudes towards HIV and condom use among internally displaced Libyan males. HIV Res Clin Pract. 2024;25(1):2305554.
17. World Health Organization. Libya health sector annual report 2021. Health Cluster; 2021.
18. World Health Organization. Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. Geneva: WHO; 2008.
19. Kallio H, Pietilä AM, Johnson M, Kangasniemi M. Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. J Adv Nurs. 2016;72(12):2954–65.
20. Bousifi N, Ibrahim K, Gumati W, Shwehdi M, Burani B. Treatment of hepatitis C in HIV/HCV co-infected with direct-acting antiviral (DAA) regimens in a single clinic in Tripoli/Libya. Int J Infect Dis. 2020;101:296.
21. Prevalence of antibodies. to human immunodeficiency virus, hepatitis B, and hepatitis C in prisoners in Libya. Libyan J Med. 2012;7(1):19713.
22. Shalaka N. Retrospective study of the prevalence of acquired drug resistance after failed antiretroviral therapy in Libya. East Mediterr Health J. 2024;30(7):470–80.

Figures

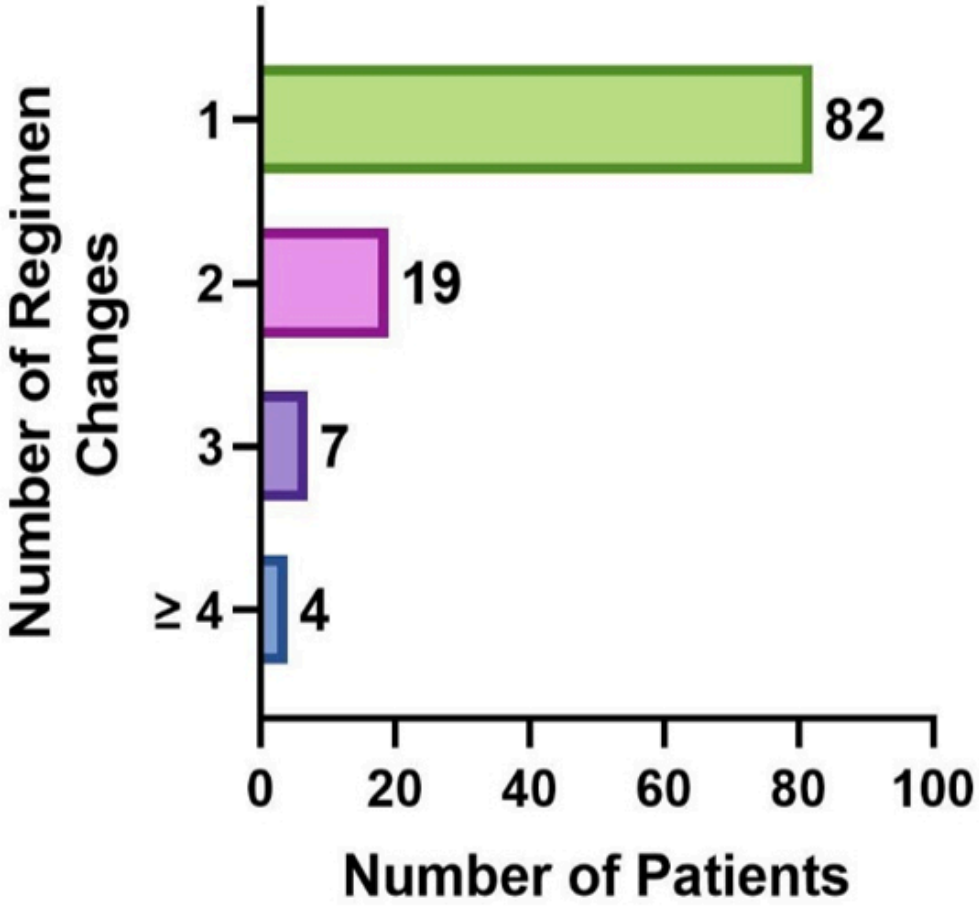


Figure 1

Frequency of ART regimen changes among patients experiencing treatment modification.

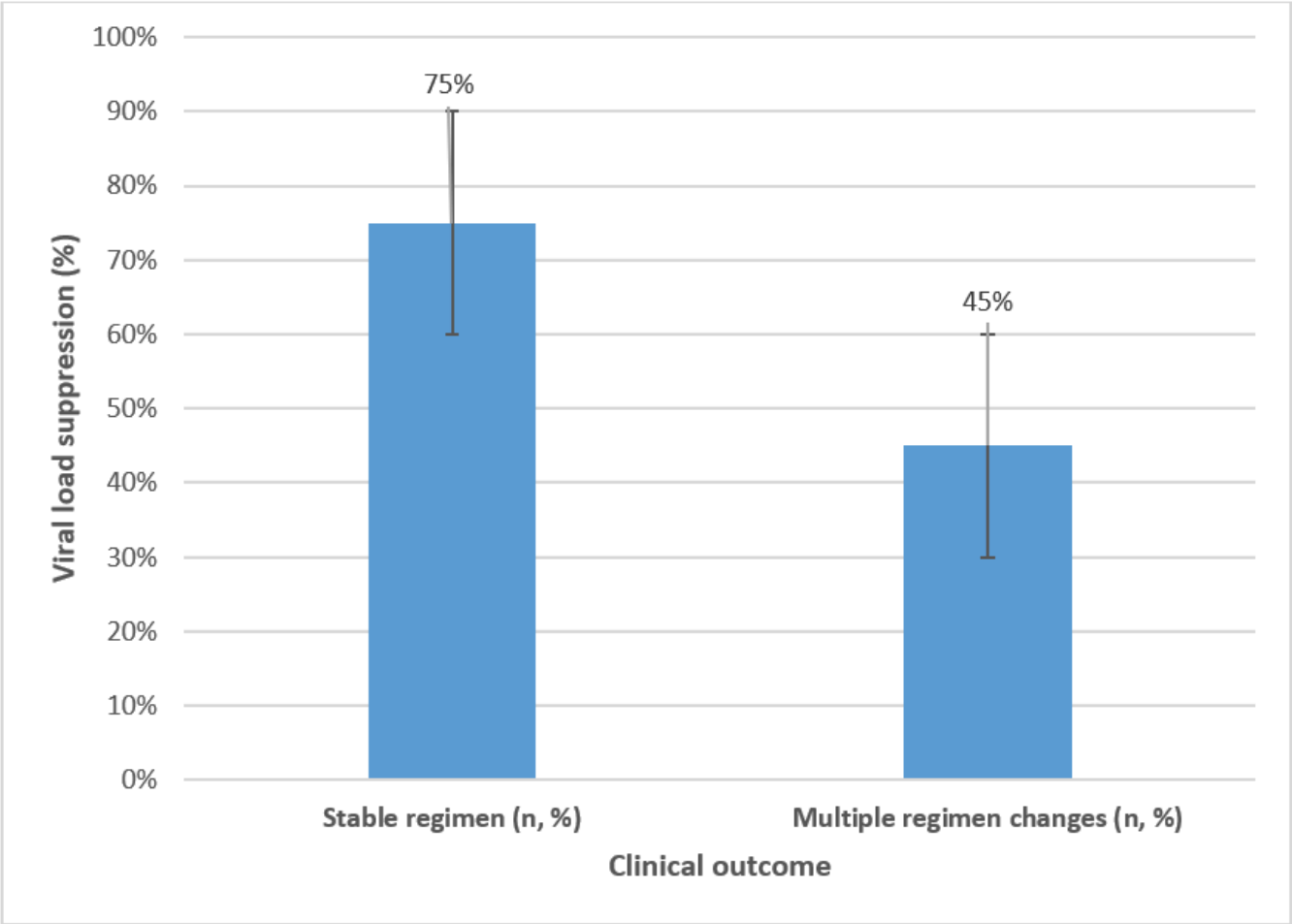


Figure 2

Association between ART regimen changes and viral load suppression

Differences between groups were statistically significant ($p < 0.01$).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- HIVARVStockoutCleanDataset2.xlsx