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Epidemiologic Trends and Determinants of Advanced HIV Disease among People Living with HIV in Zimbabwe (2017-2024): Evidence to Inform an Optimisation Framework

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Abstract

Advanced HIV Disease (AHD) remains a leading cause of morbidity and mortality among people living with HIV (PLHIV) despite widespread antiretroviral therapy (ART) coverage. This study analysed epidemiologic trends and facility-level determinants of AHD in Zimbabwe to inform targeted programme optimisation strategies. A retrospective analysis of routine District Health Information System 2 (DHIS2) data was conducted across 16 health facilities in Harare and Mashonaland East from 2017 to 2024. AHD was defined in accordance with contemporaneous World Health Organization guidelines, and analyses included descriptive statistics, temporal trend assessment, geographic comparisons, correlation, and multivariable regression. Among 495,166 PLHIV on ART, 4,169 AHD cases were identified. AHD prevalence followed a U-shaped trend, declining from 20.31% in 2017 to 2.20% in 2020, before rising to 16.12% in 2024, reflecting programmatic shifts and COVID-19 disruptions. Rural Mashonaland East recorded significantly higher prevalence than urban Harare (16.53% vs. 9.71%, p=0.002). Facility-level variation was substantial (0.56%–40.23%), with district hospitals bearing a disproportionate burden (β = 15.24, p = 0.001). AHD was positively associated with cryptococcal meningitis (r = 0.419, p = 0.003) and mortality (r = 0.385, p = 0.007), while loss to follow-up was not strongly correlated. Despite strong retention outcomes, persistent challenges in early diagnosis and AHD identification remain. Geographic and facility-level inequities underscore the need for differentiated, equity-focused interventions. Strengthening decentralised screening, particularly for opportunistic infections such as cryptococcal disease and tuberculosis, is essential to reduce preventable mortality and improve clinical outcomes.

Keywords: *Advanced HIV Disease, Epidemiology, Health Inequities, Opportunistic Infections, Program Optimization, Zimbabwe.*

Introduction

Despite sub-Saharan Africa rolling out widespread antiretroviral therapy, Advanced HIV Disease (AHD) remains the foremost cause of illness and death among HIV-positive adults. According to Huerga et al. [1], many patients in Southern Africa arrive for treatment at the final stages of infection. AHD, even with treatment, still causes the occurrence of opportunistic infections and deaths [2]. HIV service provision inequities continue to adversely affect the disease outcome in the affected population [3]. There is still inadequate explanation for the late presentation to HIV care, and this is due to a combination of structural and behavioural challenges [4]. A pertinent question in public health is what more can the health systems do to promote the early diagnosis and management of AHD to avoid avoidable suffering and death. To this end, this study seeks to assess the epidemiological

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dimensions and systemic causes of AHD in Zimbabwe. The research suggests that AHD should be viewed not merely as a clinical problem, but as an important sign of the operational capacity of health systems in relation to the accessibility of AHD services, the range and quality of services, and the overall responsiveness of health service provision.

The last two decades show a rapid growth in global HIV initiatives due to implementing antiretroviral therapy (ART), and differentiated service delivery (DSD) models. ICAP 2023 describes in many regions of Africa which have received ART, the long-term outcomes of treatment and retention and other outcomes have improved due to "patient-centered" models of care. However, in Zimbabwe Hatzold et al [5] explains that the COVID-19 pandemic caused disruptions in HIV testing and early diagnosis. Jewell et al [8] documents that in the Sub-Saharan Africa regions for the COVID-19 pandemic, the disruptions of HIV services caused late diagnosis and advanced disease progression. Moyo et al [6] advocates for the routine health information systems, including the DHIS2, which is a very important system to have to evaluate health programs and construct the necessary changes in health policy. However, the previously mentioned claims that the gaps that still exist, especially in the rural and peri-urban areas, in diagnostic, clinical and integrated management of Advanced HIV Disease (AHD) are still highly present. Therefore, the goal of this research is to develop an evidence base for an optimization framework on the identification, diagnosis, and management of AHD in Zimbabwe's national HIV program.

Research Methodology

Study Design

This study adopted a retrospective cohort method to examine the epidemiologic trends and determinants of Advanced HIV Disease (AHD) among people living with HIV (PLHIV) in Zimbabwe. This study, for the first time, analyzed epidemiological trends and determinants of Advanced HIV Disease (AHD) in Zimbabwe. The study was based on secondary data collected through the national District Health Information System 2 (DHIS2) which is the national health and program indicators repository. The study covered an Eight-year period which was selected to demonstrate the changes that occurred both in clinical guidelines and in the programmatic responses. This approach helped to determine the effect of the COVID-19 pandemic and the post pandemic case definition modifications. The data from program reports helped to perform a comprehensive system-wide analysis of the problem without the logistical and ethical challenges of obtaining primary data in a public health study [6].

Study Sites and Sampling

The study involved 16 health care facilities from two provinces in Zimbabwe: Harare Metropolitan Province (more urban) and Mashonaland East Province (more rural) and data collection from both provinces offered a comparative perspective to determine possible geographic and structural factors impacting AHD from an AHD perspective. The facilities sampled were selected purposefully to demonstrate the national health system's tiered structure and included 12 Primary Health Care (PHC) Clinics, which are the front line for HIV testing, treatment initiation and maintenance care, as well as 4 District Hospitals, which are referral centres for complicated cases, including severe opportunistic infections. Facilities selection was done using a Probability Proportional to Size (PPS) sampling method, which increased representation of the most utilized facilities (in terms of patient volume) and minimized selection bias in the estimation of indicators at the program level [3].

Data Analysis and Statistical Approach

All data management, statistical analyses, and visualizations were completed using the Python programming language and established scientific libraries to ensure consistency and reproducibility across analyses. The pandas library was employed for data management and aggregation, and statistical testing relied on *scipy* and *statsmodels*. Visualizations were generated with *matplotlib* and *seaborn* all data management, statistical analyses, and visualizations were completed using the Python programming language and established scientific libraries to ensure consistency and reproducibility across analyses.

Results

Facility-Level Distribution of AHD Burden and Mortality (2021–2024)

Analysis conducted at the facility level showed considerable variation in the Advanced HIV Disease (AHD) burden and in mortality outcomes at high-volume treatment sites for the period between 2021 - 2024. The differences in case burden and mortality by facility are due to variations in catchment population size, referral systems, diagnostic availability, and clinical management. Such patterns reflect the well documented inequalities in access to HIV services and the distribution of disease burden across health systems in sub-Saharan Africa [3]. The facility-level data is important for pinpointing high-burden service delivery points that need focused program enhancements and resource distribution.

Figure 1 presents the distribution of Advanced HIV Disease (AHD) cases and mortality rates across the ten highest-burden health facilities between 2021 and 2024, highlighting concentration of cases in high-volume urban referral facilities and variations in mortality outcomes across treatment sites.

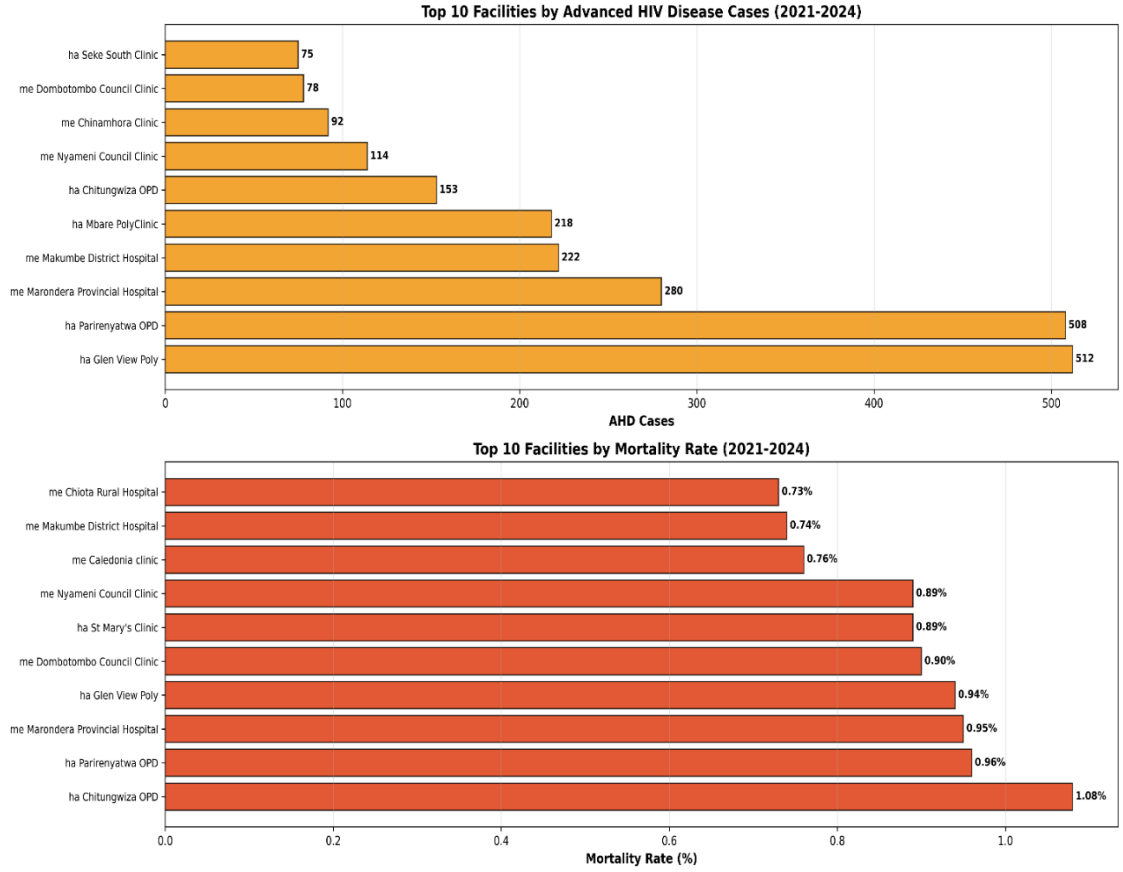

Figure 1. Top 10 Facilities by AHD Cases and Mortality Rate (2021–2024)

Figure 1 demonstrates that a notable proportion of the AHD case burden is attributable to a small number of high-volume healthcare facilities. Glen View Polyclinic is the highest reporting facility with AHD case load of 512 cases, which is closely followed by Parirenyatwa Outpatient Department, which recorded 508 cases. While Marondera Provincial Hospital has 280 cases, Makumbe District Hospital and Mbare Polyclinic have 222 and 218 cases respectively. Clinics such as Seke South and Dombotombo Council Clinic have recorded less than 80 cases. The burden of AHD cases which is concentrated on urban referral and high-density peri-urban facilities is a function of how patients are referred and diagnostics that are performed prior to patients being referred to higher levels of care [5]. The AHD case burden concentrated in urban-referral and peri-urban facilities illustrates how patients are referred and the diagnostic lag time associated with advanced care [17]. High case volumes in tertiary and referral facilities are attributed to health system organization rather than localized epidemic severity [10].

The examination of mortality rates indicated a distinct pattern from that of the case burden. Chitungwiza Hospital had recorded the most fatalities, with 1.08% followed by Parirenyatwa OPD, with 0.96% and Marondera Provincial Hospital, with 0.95%. Glen View Polyclinic had the most cases, with a mortality rate of 0.94%, which was lower than those above. Chiota Rural Hospital and Makumbe District Hospital recorded mortality rates lower than 0.75%. This data points to the fact that mortality results from a combination of factors and not just case volume, but also case severity, the availability of clinical management, and timing of the clinical presentation of infections [18].

The highlights of mortality and case burden divergences indicate potential programming. For example, a high volume of cases at a healthcare facility does not guarantee a high mortality rate. This could be a result of a more robust healthcare facility with more effective clinical management, diagnostics, and institutional healthcare management. In contrast to that, more moderate case healthcare facilities with late presenting cases could witness higher mortality rates than the optimally specialised healthcare facilities. This would indicate the need to design differentiated service delivery models that respond more effectively to the specific needs of the individual healthcare facilities and the healthcare immediacy of the patients [6].

The research confirms that facility-level heterogeneity is a signature of AHD epidemiology. Enhancing diagnostic decentralization, workforce strengthening, and opportunistic infection screening at high-burden and high-mortality facilities will be pivotal in diminishing preventable deaths alongside an expansion of clinical outcomes within the HIV clinical care cascade at a national level [15].

Subnational Distribution of AHD Prevalence, Mortality, and TB Coinfection Burden (2021–2024)

Research shows AHD and death rates, as well as rates of opportunistic infections, are not consistent across the provinces studied. This is due to differences in the accessibility of services, how patients are referred, the geography of the population, and the time interval when people are diagnosed with HIV. An enduring aspect of the HIV epidemic in sub-Saharan Africa is the unequal HIV outcomes over different regions which demands targeted programmatic intervention [3]. Figure 2 illustrates district and provincial variations in Advanced HIV Disease (AHD) prevalence, mortality rates, and tuberculosis coinfection between 2021 and 2024, highlighting higher AHD prevalence in rural Mashonaland East than in urban Harare and substantial differences across districts.

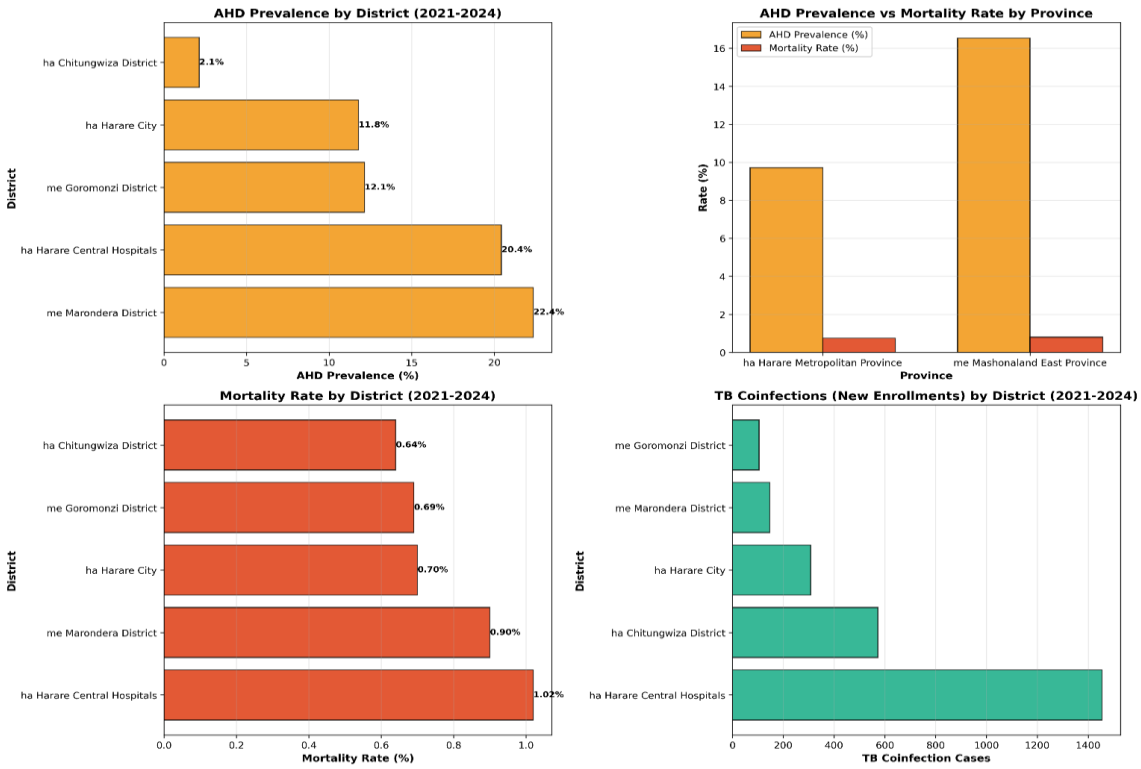

Figure 2. District and Provincial Distribution of AHD Prevalence, Mortality, and TB Coinfections (2021–2024)

Figure 2 demonstrates substantial geographic variation in the burden of Advanced HIV Disease (AHD) and associated clinical outcomes across districts and provinces between 2021 and 2024. Marondera District recorded the highest AHD prevalence (22.4%), followed by Harare Central Hospitals (20.4%), while Chitungwiza District reported the lowest prevalence (2.1%). Mortality rates were highest at Harare Central Hospitals (1.02%), reflecting the concentration of severe referral cases. Provincial comparisons indicate a higher AHD prevalence in rural Mashonaland East (16.53%) compared with urban Harare (9.71%), although mortality differences remained relatively small. In addition, tuberculosis coinfections were disproportionately concentrated in major referral centres, particularly Harare Central Hospitals, highlighting the relationship between advanced immunosuppression and opportunistic infections in high-burden treatment facilities.

Table 1 presents a comparison of key indicators between rural and urban settings for the period 2021–2024.

Table 1. Urban-Rural Comparison of Key Indicators (2021-2024)

Setting	PLHIV on ART	AHD Prevalence (%)	Mortality (%)	LTFU (%)
Rural	69,931	16.53%	0.80%	4.51%
Urban	183,893	9.71%	0.74%	4.90%

However, there was wide variation in the prevalence of AHD across districts within the various study sites. Marondera District had the highest prevalence at 22.4%, as shown in Table 1, while Harare Central Hospitals had a prevalence of 20.4%. Moderate prevalence levels were reported in Goromonzi and Harare City at 12.1% and 11.8%, respectively, while Chitungwiza District had the lowest prevalence at about 2.1%. These findings show a clear variation in the timing of diagnosis and linkage to care across districts. The higher prevalence

of AHD in some districts aligns with the presentation delays and diagnostic access challenges noted in Southern Africa [5].

There was also a clear rural-urban gradient in the provincial comparisons. A prevalence of AHD was about 16.5% in Mashonaland East, while in Harare Metropolitan Province, it was 9.7%. The differences in mortality between the provinces were small, with Mashonaland East having approximately 0.80% and Harare around 0.74%. This pattern indicates that while the rural population has to bear a greater disease burden at presentation, the clinical outcomes may be similar across provinces once patients enter the care system. This has also been documented in previous evaluations of regional HIV programs where there is a standardization of treatment in order to reduce the variability of outcomes after linkage to care [10].

There were significant differences in the patterns of deaths across districts. The highest death rate was recorded by Harare Central Hospital with a death rate of around 1.02%. It was closely followed by Marondera District with approximately 0.90%. Mortality rates of Harare City and Goromonzi were below 0.70%, and Chitungwiza had around 0.64%. It is possible that higher mortality rates in referrals and in high-volume facilities indicate the concentration of more severe AHD cases rather than poorer illness care. Hospitals that are referrals deal with complex cases of opportunistic infections and late presentations of the disease where advanced clinical interventions are needed [18].

There was a strong clustering of TB coinfection burden within specific districts. Over the Study period, Harare Central Hospitals had the highest TB coinfection burden with more than 1,400 counted cases. Moderate TB coinfection burden was seen in Chitungwiza and Harare City, while Marondera and Goromonzi recorded smaller figures. The high concentration of TB coinfections in high-volume referral facilities indicates both the diagnostic capacity and the referral of a body of severely immunocompromised patients. TB continues to be a significant cause of disease and death in people with advanced HIV disease, and is closely associated with late diagnosis and the degree of immunosuppression [9].

The above-mentioned patterns in geography show how important customised HIV service delivery patterns are for each location. Rural and peri-urban regions with a greater AHD prevalence demand more robust and improved pathways for early diagnosis and linkage to care for screening and care middle for OP and CD4 opportunistic infections. Increased capacity for management of AHD (including TB and cryptococcal disease) for inpatient clinical management is also needed at high-burden referral sites. Focused geo-resource allocation is still needed to lower avoidable AHD-related deaths and enhance the equity of the country's HIV program [15].

District-Level and Facility-Level Analysis of AHD Burden

District-Level Disparities

According to this burden analysis, there are disparities at the district level that cannot be explained solely by district size or HIV case numbers. For instance, the Marondera District has been described as the most difficult district in this study, as it has the highest AHD prevalence of 22.36% (487 cases). In addition, Marondera District accounts for 13.6% of the study population, and, being predominantly rural, this suggests challenges with late presentation and links to care in Marondera. In comparison, the Harare Central Hospitals, which are tertiary referral hospitals for complex cases have a prevalence of 20.43% (661 cases); thus, this prevalence is a function of the hospital and not the local AHD burden. It is also important to point out that the Chitungwiza District, which has the highest number of patients (32.7%), AHD prevalence, 2.13% (135 cases), is very low. This shows that Chitungwiza has good AHD control with early case finding and treatment.

The significant variances in AHD prevalence across the districts e.g. Chitungwiza's 2.13% AHD prevalence compared against Marondera's 22.36% AHD prevalence highlights the potential of local data to understand access and variations in local testing/referral(s) programs to explain variations in AHD epidemiology, even under the uniformity of a single national healthcare system. The relationship of apparent patient volume, AHD prevalence, and the inverse in Chitungwiza District, indicates that this is a potential AHD low-burden district where significant service delivery, or more so than in other low-burden districts, AHD is being demonstrated. The low prevalence of AHD in Chitungwiza District is paradoxically associated with higher cryptococcal meningitis, tuberculosis, and other opportunistic infections. This apparent paradox, in relation to the high level of AHD, suggests either exceptional diagnostic vigilance at Chitungwiza sites where opportunistic infections are actively sought, or that patients are being identified and treated for opportunistic infections before reaching the AHD threshold, demonstrating a model of success for opportunistic infections (CD4) secondary prevention.

Temporal Program Performance and Clinical Outcome Trends (2017–2024)

Facility and program performance trends from 2017 to 2024 show considerable changes in ART coverage and in the burden of Advanced HIV Disease (AHD), mortality, and opportunistic infection patterns. These metrics capture both the health system's performance and the shifting dynamics of the epidemic. Such changes are essential for evaluating the national HIV program and monitoring potential new threats [11]. Figure 3 illustrates temporal trends in ART coverage, AHD prevalence among new ART initiations, mortality, loss to follow-up, and cryptococcal meningitis cases between 2017 and 2024, highlighting improved treatment coverage alongside fluctuating burdens of advanced disease and opportunistic infections over time.

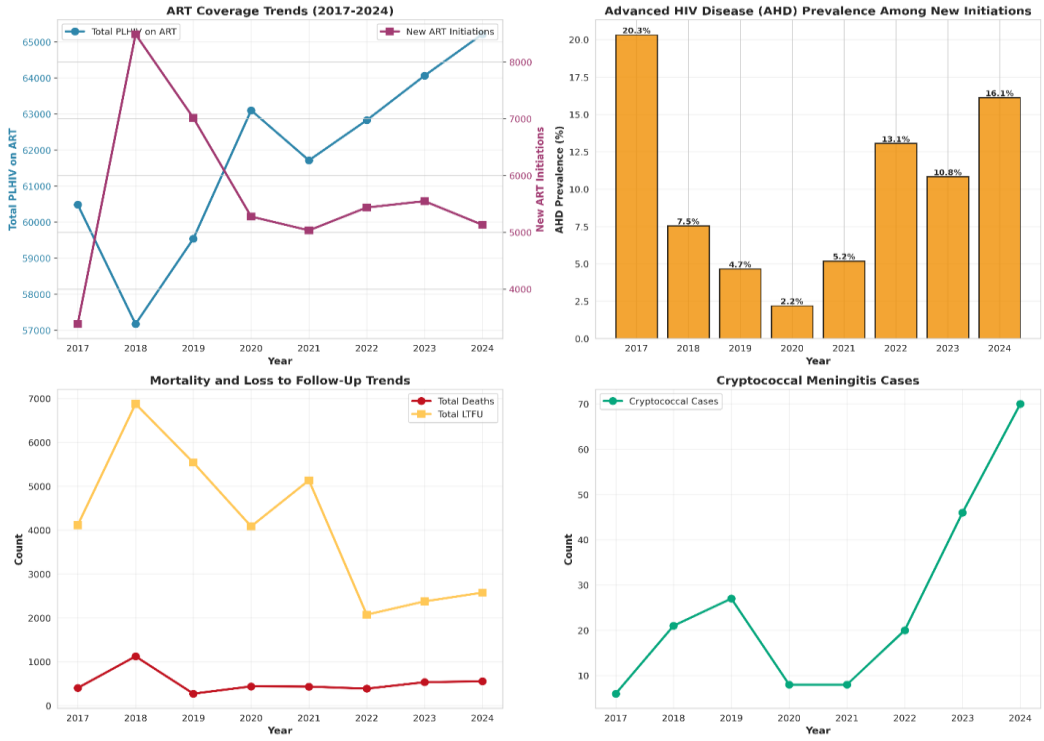

Figure 3. ART Coverage, AHD Prevalence Among New Initiations, Mortality, LTFU, and Cryptococcal Trends (2017–2024)

Figure 3 illustrates temporal trends in ART coverage, AHD prevalence among new ART initiations, mortality, loss to follow-up, and cryptococcal meningitis cases between 2017 and 2024. ART coverage steadily increased over the study period, reflecting the continued expansion of treatment programmes. However, AHD prevalence followed a U-shaped trend, declining from 20.3% in 2017 to 2.2% in 2020 before rising again to 16.1% in 2024. Mortality and loss-to-follow-up trends fluctuated but generally declined after 2021, indicating improvements in retention and treatment continuity. Conversely, cryptococcal meningitis cases increased toward the end of the study period, highlighting the persistent burden of opportunistic infections associated with late HIV diagnosis and advanced immunosuppression.

During the study period, there was a gradual expansion of ART coverage. Overall increase remained consistent despite temporary fluctuations from 2017 and 2019. New ART initiations, which peaked in 2018, plateaued at moderate levels. This phenomenon mirrors the expansion and plateauing of new enrolments as retention improves. Service reductions and new enrolments were disrupted because of COVID-19 [4].

The AHD prevalence of new ART initiations follows a U-shaped trend. Prevalence decreased from 20.3% in 2017 to 2.2% in 2020, then rose again to 16.1% by 2024. Early testing and treatment scale-up explain the initial decline. The 2020 nadir, amid COVID-19, saw substantial service disruptions. The following increase presents a situation of neglected diagnosis, missed treatment, and an infectious disease on the re-engagement of patients previously suffering advanced illness [7].

Between 2018 and 2022, there was a peak and subsequent decline in loss-to-follow-up (LTFU) mortality. Referrals to loss to follow-up (LTFU) mortality were approximately 2,000 to 2,600 per year during that time range. Mortality rates also fluctuated, but remained consistent and steadied after 2022 [17]. There were improvements in retention, reflecting the scale-up of differentiated service delivery models in multi-month dispensing and community-based ART delivery approaches [17].

Prior to 2022, there was also a persistent retention and mortality paradox, and retention improvements were attributed to late presentation and advanced disease complications.

2024 is predicted to have approximately 70 incidences of cryptococcal meningitis. Cryptoccal disease is an indicator of late presentation/advanced immunosuppression due to HIV. HIV is an issue that also increases the prevalence of cryptococcal disease and it is anticipated that there will be an increased burden of cryptococcal disease due to the lack of early diagnosis and treatment of HIV, despite the ART advancements.

Zimbabwe's HIV program retention and ART coverage reflects the major disease burdens that advanced clinical disease provides. A greater emphasis on these advanced disease clinical burdens is needed to improve earlier diagnosis, and to additionally improve the initiatives aimed at opportunistic infection screening and advanced disease management [15].

Correlation Analysis

Figure 4 presents the correlation matrix between Advanced HIV Disease indicators and clinical outcomes, alongside a comparison of key indicators between urban and rural settings, highlighting stronger AHD prevalence in rural areas despite similar mortality rates across both settings.

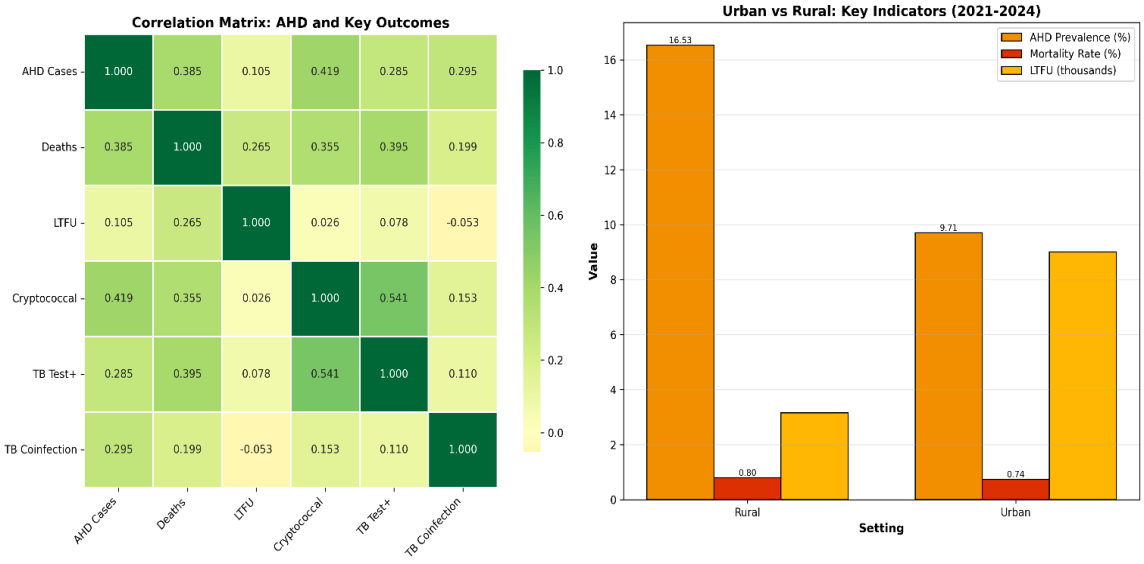

Figure 4. Correlation Analysis and Urban vs Rural: Key Indicators (2021-2024)

Figure 4 presents the correlation matrix between Advanced HIV Disease (AHD) burden and key clinical outcomes, alongside a comparison of indicators between rural and urban settings. The analysis shows moderate positive correlations between AHD cases, mortality, and opportunistic infections, particularly cryptococcal disease. Rural settings had a higher AHD prevalence (16.53%) than urban areas (9.71%), although mortality rates were similar in both settings. These patterns highlight the influence of delayed diagnosis and access barriers in rural populations rather than differences in treatment quality after patients enter the care system.

The correlation matrix shows the burden of advanced HIV disease (AHD) and clinical outcomes. There is a moderate positive relationship with AHD cases and deaths (r = 0.385), advanced disease burden is associated with higher mortality risk. A strong positive relationship is seen for cryptococcal infection and TB test positivity (r = 0.541). Implies a high-risk population of overlapping and immunosuppressed individuals. Integration of screening and management strategies for opportunistic infections is needed.

There is a clear contrast in AHD prevalence between rural areas (16.53%) and urban areas (9.71%) in the urban-rural approach. Mortality shows little variation in both urban (0.74%) and rural (0.80%) areas. There is a higher LTFU rate in urban cohorts, likely reflecting larger treatment populations rather than poorer retention outcomes. These findings demonstrate inequities driven by higher AHD disease burden and more by delayed diagnosis and access barriers than poorer treatment quality after entering the care continuum [17].

Bivariate correlation analysis serves as an additional measure of relationships within the AHD clinical cascade. There is a statistically significant positive correlation with a value of 0.419 and a p-value of 0.003 regarding AHD cases within the facilities and cases of cryptococcal meningitis. This is a positive correlation due to biological plausibility, since cryptococcal disease occurs in severe immunosuppression (CD4 <100 cells/µL). This relationship reinforces the WHO recommendations stating that AHD diagnoses automatically require a cryptococcal antigen test. This is a true high-yield, potentially life-saving intervention [19].

A statistically significant correlation (p=0.041) with a correlation coefficient of 0.295 was observed between AHD burden and TB coinfection. This relationship is weaker and may reflect variability in TB diagnostic practice, especially in the use of TB-LAM and

TB molecular testing. In advanced disease, extra-pulmonary TB may contribute to the under-detection and therefore weaken the statistical association. There is a displayed need in the AHD population for further standardized TB screening protocols [8].

There is no statistically significant association between AHD burden and loss to follow-up ($r = 0.105$, $p = 0.342$). This means that the drivers of disengagement from care is more socio-economic and behavioural than biological. Those advancing to AHD are most certainly late presenters and treatment failure patients who remain in care. This justifies the need for dual-program approaches aimed at both strengthening retention and focused clinical AHD management for high-risk patients already in treatment programs [14].

Discussion

Key Findings in Context of the National and Regional HIV Response

This comprehensive eight-year analysis reveals both the substantial progress and the persistent, There are several challenging aspects when it comes to the management of Advanced HIV Disease (AHD) within Zimbabwe's evolving HIV program. The fact that ART data from 2021–2024 shows that AHD was present in 12.82% of the cohort participants is framed regionally; there are various literature reports that document that 10–50% of people living with HIV in sub-Saharan Africa are known to start antiretroviral therapy at an advanced stage of immunosuppression [1]. The ongoing burden illustrates that although there are notable advancements in the scaling of treatment coverage, a high number of people still come into contact with the health system, only after they have suffered a high degree of immune compromise, significantly increasing their risk of morbidity and mortality. The findings of the study emphasize the fact that AHD is still a fundamental component in the fight to control HIV and it needs to be of primary focus in addition to treatment quotas.

Interpretation of Multifaceted Temporal Patterns

The U-shaped pattern in AHD prevalence between 2017 and 2024 indicates more than a simple epidemiological signal, considering evolving guidelines, health system changes, and external shocks. The 2017-2018 peak, with the larger CD4 < 350 cells/mm³ definition, likely depicted the historical pattern of late diagnoses and more advanced immunosuppression. The following rapid decline to the 2020 nadir reflects a complex interplay of factors, including a new and improved CD4 testing system for earlier diagnosis; mature "test and treat" policies facilitating rapid ART initiation; and likely, the significant, yet artificial, depression of new diagnoses due to the routine HIV services collapse caused by the COVID-19 pandemic [8].

An analysis of the worrying and renewed increase of the prevalence from 2021 onward, especially under the newly defined and more stringent CD4<200 criteria, requires a complicated analysis. At least three potential causes can be identified: the first being the backlog of undiagnosed disease that has progressed due to the disease-related lockdowns and is now entering the care system; the second relates to the possible diminishment of routine CD4 monitoring, as programmatic shifts focus to the viral load (VL) monitoring to assess treatment success, thereby allowing the tacit and silent immunological failing to go undetected; and the third is the revealing of deep, entrenched systemic issues, including stigma, poverty, and geographic isolation, which uninterruptedly lag the diagnosis of advanced disease in the critical and marginalized populations in the outlying areas and actively perpetuate the undiagnosed diseased pool[2]. Such an analysis as the fragile health system can be resilient to the most significant areas of shock and demonstrates the need for a system that is flexible enough to be adjustable to ensure uninterrupted service

delivery that includes both testing and treatment services in a time of need [13].

Addressing Profound Urban-Rural Disparities in AHD Burden

The analysis discovered an alarming and critically programmatic disparity, with rural settings experiencing a 70% greater burden of AHD compared to urban settings [13].This constitutes direct epidemiological mapping of inequities in healthcare access. It highlights the structural determinants operating in rural Zimbabwe. These include elongated distances to healthcare services, unreliable transport, increased poverty that limits individuals from seeking healthcare, and an absence of healthcare personnel and diagnostic services [13]. These obstacles create a cascade of delays that hinder the initial testing, the timely linking to care, and ultimately retain individuals in a cycle of care to allow HIV to progress.

This essay aims to make sense of the paradox of the other mortality rates, considering the severity of the illness, the locations, and the other rural regions. Rural patients overcome barriers to receiving clinical care as good as urban care. This shows that the countries have established protocols for rural clinical care. However, the good outcomes for rural mortality mask an even bigger problem. Patients are diagnosed too late in rural areas. Trying to explain the urban hospitals' number of deaths shows the problem and the level of mortality that results from rural deaths. The mortality resulting from sending patients to urban hospitals is a problem originating in rural areas. The situation shows that more control is needed to improve them. Simple control over how and where to improve testing and referral infrastructure in rural areas will reduce mortality. This will improve mortality in rural areas and move toward real control of the rural areas.

The Critical and Quantifiable Link to Opportunistic Infections

The analyses demonstrate biocorrelation evidence with a statistically significant relationship between advanced immunosuppression and severe opportunistic infections (OIs) of multiple severe opportunistic infections types. The statistically significant relationship ($r=0.419$, $p=0.003$) between AHD and cryptococcal meningitis, and hence, the clinical rationale of bundled screening. The marked increase in cryptococcal meningitis cases, rising from 46 to 70 cases between 2023 and 2024, highlights a growing burden of severe opportunistic infection and underscores the potential for preventable mortality if early screening is not strengthened. This pattern reinforces the life-saving and cost-effectiveness of routine cryptococcal antigen (CrAg) screening for patients with CD4 <200 cells/mm³, as recommended by WHO [11]. On the other hand, the moderate relationship with TB ($r=0.295$, $p=0.041$) confirms the opposite and more likely, a programmatic gap instead of a weak biocorrelation. The likely explanation for the weakened relationship is the poor implementation of TB screening approaches (e.g., TB-LAM or Xpert Ultra) in AHD patients which leads to under diagnosis of disseminated and extrapulmonary TB [16]. There is a clear need for not only combined screening, but also clear expectations for the standardization of sensitive TB screening, to match the high-risk TB infection at AHD.

Program Performance, Strategic Insights, and Future Direction

One of the most notable impacts of the improvements made to the patient-centered service delivery adaptations (ICAP, 2023), including multi-month dispensing (MMD) and community ART groups, to LTFU, is the decline of LTFU rates to less than 4% in the post- 2021 period. And 2021’s LTFU rates of 12% show impressive growth. This is the first time any report has shown LTFU rate of less

than 4% since 2021. Nevertheless, the most important learning perspective of the study is the lack of significant relationship between LTFU and AHD. This indicates that AHD is not a disease of the lost to follow-up patients, but rather, AHD occurs substantially among retained patients. This is attributed to either a late-stage disease, or a case of clinical failure which is when patients are ART and have un-suppressed viremia and/or have receded their immune system, despite being retained [2]. Therefore, the program must change direction to incorporate the retention focus and also the AHD.

The Zimbabwe HIV response's focus on ensuring the quality of survival from simply monitoring retention illustrates the development of HIV response and its intention to reduce mortality of the most vulnerable patients and provide equal health outcomes for all.

Conclusion

This paper analyzes the expanding burden and drivers of Advanced HIV Disease (AHD) within the scope of epidemiology, specifically, the Zimbabwean national HIV programme. The overall outcome of the programme has been benefited by the increase of antiretroviral therapy and retention of patients. However, the programme continues to be affected by structural and operational challenges, which lead to the presentation of advanced stages of HIV disease. This study provides evidence to the AHD geographical inequities. The burden of AHD is disproportionately more in rural and peri-urban populations as compared to urban populations. AHD burden inequities across districts and facilities underscore that AHD outcomes are a function of the health system's operationality, the availability of AHD diagnoses, and clinical management of AHD in the area. There is no doubt that a differentiated, context-specific approach is warranted, rather than the traditional homogeneous national approach to targeting, treating, and (where possible) managing high-risk actors.

The program perspective suggests the study proposes the application of multiple components optimization approach focusing on fortifying diagnostics, clinical management, supply chain management, and community-oriented services. To mitigate the delays in clinical decision-making and facilitate early detection of immunosuppression, accessing CD4 testing at the primary health care level is vital [9]. Routine screening for opportunistic infections, particularly cryptococcal infections and TB (especially in suspected TB), should use TB-LAM technology as part of the AHD screening package. It is anticipated that the strengthening of clinical care pathways through standardisation of treatment protocols, specialised simulation-based training, and mentorship of tertiary-level specialists to district-level clinicians will enhance clinical engagement and clinical outcomes. Additionally, improved commodity forecasting, establishment of strategic buffer stocks, and integration of real time digital stock management to the health information system of the respective country will reduce stock-outs and improve supply chain management. Targeted HIV testing, peer support models, and differentiated service delivery for AHD patients, at the community level, improve late presentation, treatment adherence, and survival outcomes of AHD patients.

There are great many weaknesses in this study. The routine health facility data relies on data collection routine, therefore, it may underestimate the burden of AHD, depending on the coverage of CD4 testing. It is challenging to make direct temporal comparisons due to the disparate AHD case definitions and CD4 count thresholds across the study timeline. Nevertheless, impacted stratified effect the Analysts conducted. The Inherent study design elements will make it impossible to establish any cause and effect

relationships in AHD and the implicated factors in the AHD outcomes. The province selection, which included only two provinces, and this was methodologically justified in terms of a comparative study, will probably lower the degree of national generalisability. The absence of certain key demographic data elements such as age and sex, and key population- category data limited the analysis of subgroups that are considered to be at increased risk, and this is also a limitation.

Conflict of Interest

The author declares no conflicts of interest regarding publication of this scientific article.

Ethical Approval

Authority to use the National HIV program data was sought and granted by the Ministry of Health and Child Care of Zimbabwe. Ethical approval to conduct the research was also granted by Texilla American University.

Data Availability

Anonymised pooled data is provided by the author. The data may be made available to interested researchers through formal data access requests under the jurisdiction of Zimbabwe's Ministry of Health and Child Care.

Author Contributions

- **Sandra Chipuka:** Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing-Original Draft Preparation, Writing-Review & Editing, Visualization, Project Administration.
- **Emmanuel Govha:** Writing-Review & Editing.
- **Chiedza Mupanguri:** Writing-Review & Editing.
- **Japhet Anesu Mabuku:** Data curation and analysis.A

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