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ANALYSIS OF VIRAL LOAD RESPONSE IN CHILDREN LIVING WITH HIV AGED 5-19 YEARS ON ANTIRETROVIRAL TREATMENT AT 9 BULAWAYO CITY CLINICS, ZIMBABWE, 2021-2023

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH IN THE COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

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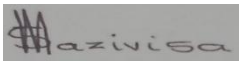
Abstract

Zimbabwe is one of the countries in sub-Saharan Africa disproportionately affected by the human immunodeficiency virus. The country has made great strides in scaling up ART using the "treat all" strategy. Regular viral load monitoring is essential for managing HIV effectively, particularly in children. However, the viral load suppression remains below the target of 95% that the country aims to achieve. A retrospective cohort study using secondary data analysis was done to analyse viral load response in CLHIV aged 5-19 years initiated on ART at nine BCC-supported clinics from January 2021 -June 2023. The viral response was measured using documented viral load results for VL samples done 6-9 months post ART initiation. A total of 199 study participants were included in the study. Convenience sampling was used to select the nine facilities and study participants were selected through random stratified sampling. The results show that 86.5% of participants underwent viral load testing at six to nine months post ART initiation to measure viral load response. 74.4% were virally suppressed,12.1% were unsuppressed and 13.6% had unknown viral load response due to missed opportunities even though they were active on treatment. There was a statistical significance between adherence and viral load response (p= 0.000), age group and gender (p = 0.001), orphan status and adherence (p=0.035). There was a strong association between adherence level and viral load (Cramer's V=0.497). In addition, there was a moderate association between age group and adherence (Cramer's V=0.262) and orphan status and adherence (Cramer's V=0.209). Viral load suppression was highest for the age group 5-9 years at 94.1%, followed by the 10-14 age group with the least performance by the 15-19 years age group at 70.2%. Notably, the 15-19 years age group accounted for 91.7% of the total participants with unsuppressed viral load. However, statistically, findings show no significance (p=0.155). Conclusion**:** At six months of ART, viral suppression was low and significant missed opportunities for viral load monitoring in the cascade There is an urgent need to scale up the implementation fidelity of routine viral load monitoring to mitigate missed opportunities. In addition, to improve treatment literacy.

Keywords: Children living with HIV, Viral load response, virally unsuppressed, virally suppressed, optimal and sub-optimal adherence.

Declaration

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree.

Sithembinkosi Mazivisa 

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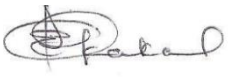
Mr E Chikaka 

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Dedication

I dedicate this dissertation to my late parents, Mr & Mrs JR Sibanda and my young brother Nkosilathi Sibanda for being my intercessors and a great inspiration in my life.

List of Acronyms and Abbreviations

ABC/3TC/DTG	Abacavir / Lamivudine / Dolutegravir
ABC/3TC/EFV	Abacavir / Lamivudine / Efavirenz
ABC/3TC/LPV/r	Abacavir / Lamivudine / Lopinavir/ritonavir
AZT/3TC/DTG	Zidovudine / Lamivudine / Dolutegravir
AIDS	Acquired Immunodeficiency Syndrome
ART	Anti-Retroviral Therapy (ART).
AUREC	Africa University Research Ethics Committee
CLHIV	Children Living with HIV
EHR	Electronic Health Records
HBM	Health Belief Model
HIV	Human Immunodeficiency Virus
MoHCC	Ministry of Health and Child Care
PLHIV	People Living with HIV
TDF/3TC/DTG	Tenofovir Disoproxil Fumarate / Lamivudine / Dolutegravir
TDF/3TC/EFV	Tenofovir Disoproxil Fumarate / Lamivudine / Efavirenz
UNAIDS	United Nations Joint Programme on HIV/AIDS
VL	Viral Load

Definition of key terms

Adherence refers to the ability of a patient to take their ART medications as prescribed. Adherence rates of 95% or higher are typically necessary to achieve optimal viral suppression and prevent drug resistance (CDC,2020).

Double orphan is defined as a child under 15 years who has lost both parents (WHO,2018).

Single orphan is defined as a child under 15 years who has lost one parent (WHO, 2018).

Viral load refers to the quantity of HIV RNA in the blood, which is essential for monitoring treatment efficacy (WHO, 2016).

Viral load monitoring is defined as the regular measurement of the amount of HIV RNA in a patient's blood. This monitoring is essential for assessing the effectiveness of ART, guiding treatment decisions, and ensuring sustained viral suppression (WHO,2016).

Viral load response is defined as the change in the amount of HIV RNA in the blood after initiating ART. A successful response is indicated by a reduction to an undetectable level, less than 1000 copies/ml (CDC, 2020).

Viral load suppression entails achieving an undetectable viral load, less than 1000 copies/ml which is vital for effective HIV management (WHO, 2016).

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CHAPTER 1 INTRODUCTION

1.1 Introduction

HIV remains a significant global health challenge, particularly among children. According to the Joint United Nations Programme on HIV/AIDS (UNAIDS), approximately 1.7 million children under the age of 15 were living with HIV by the end of 2021, with the majority residing in sub-Saharan Africa (UNAIDS, 2022).

In Zimbabwe, the prevalence of HIV among children and adolescents is a major challenge, requiring targeted interventions to improve health outcomes (UNAIDS, 2021). Antiretroviral therapy (ART) is crucial for managing HIV in children, as it significantly reduces viral load, and improves immune function, and overall health outcomes (World Health Organization, 2021). Current ART guidelines recommend 'test and treat", emphasizing the importance of ART adherence to achieve viral suppression.

The UNAIDS initiative aims for 95-95-95 targets (UNAIDS, 2023). Achieving these targets is critical for improving health outcomes, reducing transmission, and improving the overall quality of life for CLHIV (Bouwman et al.,2021). Viral load response is the change in the quantity of HIV in the bloodstream after initiation of antiretroviral therapy. It is measured in copies of viral RNA per millilitre of blood (Mocroft et al., 2019).

A successful response is indicated by a reduction of viral load to an undetectable level, less than 1000 copies/ml (CDC, 2020). Achieving and maintaining viral suppression is vital not only for the health of the individual but also for reducing transmission rates within the community (Cohen et al., 2016). As such, regular monitoring of viral load is critical for assessing the effectiveness of ART and making necessary adjustments to the treatment plan.

Several factors influence viral load response in children on ART. The age group of 5-19 years is crucial, as it encompasses a transition period where individuals may face unique challenges related to treatment adherence, psychosocial development, and access to healthcare services (WHO, 2022).

Medication adherence is important, studies indicate that optimal adherence can improve treatment outcomes significantly (Kacanek et al., 2019). However, various barriers exist, including family dynamics, socioeconomic status, and mental health issues. Additionally, comorbid conditions such as malnutrition or opportunistic infections can complicate treatment and affect viral load outcomes.

Despite advancements in ART, CLHIV in Zimbabwe continues to face challenges in achieving optimal viral load suppression, often influenced by a variety of factors such as socioeconomic level, stigma, and access to healthcare services (Mavhu et al., 2021).

In Bulawayo, both local and systemic factors influence the HIV care management for CLHIV. Access to healthcare resources and family socioeconomic status have a major impact on health outcomes (Chikwari et al., 2022). Furthermore, psychosocial factors, such as mental health and social support systems, play a crucial role in the adherence to treatment and the overall well-being of CLHIV (Mavhu et al., 2021).

This study analysed the viral load response in children aged 5-19 years living with HIV initiated on ART in Bulawayo from January 2021 to June 2023. In addition, the research identified the demographic and clinical characteristics associated with varying levels of viral load suppression. The research aimed to understand how adherence to ART impacts viral load response in CLHIV and to inform the formulation of targeted interventions and improve health outcomes.

1.2 Background to the Study

Globally, approximately 54% of children living with HIV are receiving ART. Among those on treatment, about 79% achieve viral load suppression (UNAIDS, 2022). WHO has emphasized the importance of achieving viral load suppression as a critical component of effective HIV management, aiming for 95% of people on ART to achieve viral suppression by 2030 (WHO, 2021). However, disparities in treatment access and adherence persist, particularly in low- and middle-income countries, where children face unique challenges in managing their health.

In the Southern Africa, the burden of HIV is particularly high. Countries such as Zimbabwe, South Africa, and Zambia have some of the highest prevalence rates of HIV globally. The region accounts for approximately 55% of all people living with HIV, with children and adolescents being disproportionately affected (UNAIDS, 2021). Despite the implementation of the "treat all" policy, many children still experience barriers to accessing treatment and achieving viral load suppression. Factors such as stigma, healthcare access, and socioeconomic challenges significantly impact treatment adherence and health outcomes in this demographic (Mavhu et al., 2019).

Zimbabwe has made significant strides in its response to the HIV epidemic, with an estimated 1.4 million people living with HIV, including 70 000 children aged 0-14 years (UNAIDS, 2023). The National ART guidelines recommend routine viral load monitoring for effective treatment outcomes. As of 2021, around 90% of children diagnosed with HIV were on ART, with approximately 85% achieving viral load suppression (MoHCC,2021). The country has implemented various strategies, including community-based programs and integrated healthcare services, to improve treatment adherence and viral load monitoring.

The coverage of ART among children and adolescents in Bulawayo has been a focus of recent studies. UNAIDS (2023) reporting the progress towards the 95-95-95 targets, noted that in Bulawayo, the treatment cascade and progress towards 95-95-95 targets for CLHIV was 86-100-91. Contrastingly, Moyo et al (2021), established that 54% of CLHIV at Mpilo were virally suppressed at six months post-ART initiation and 18% were virally unsuppressed. As such, there is a critical need to analyze factors influencing viral load response among CLHIV 5-19 years on ART.

Understanding these factors is essential for developing targeted interventions that can improve adherence to ART and health outcomes for CLHIV. In addition, as HIV management continues to evolve, it is imperative to understand the factors influencing viral load response in children living with HIV.

This study sought to fill the gap in knowledge regarding viral load response and associated factors in children living with HIV in Bulawayo from 2021 to 2023, contributing to the broader understanding of pediatric HIV care in Zimbabwe and informing future healthcare policies.

1.3 Statement of the Problem

Despite significant advancements in the provision ART, achieving optimal viral load suppression in CLHIV remains a critical challenge. In Bulawayo, viral load suppression was 54% for CLHIV initiated on ART from January 2017 to December 2018 at Mpilo (Moyo et al., 2021). This gap in viral load response is concerning, as sustained viral suppression is critical for improving health outcomes and preventing HIV transmission. In addition, there is a scarcity of local data analysing the factors affecting viral load response in CLHIV limiting the development of targeted interventions (Ndlovu et al., 2022).

Therefore, there is an urgent need to examine the viral load response to ART among CLHIV in Bulawayo to show baseline viral load coverage amongst CLHIV on ART, analyze adherence rates and their impact on VL suppression, and identify sociodemographic factors that influence VL response.

1.4 Research Objectives

1.4.1 Broad Objective

- To analyze the viral load response and its determinants in children aged 5-19 years living with HIV on antiretroviral therapy (ART) at nine Bulawayo City Council clinics in Zimbabwe from 2021 to 2023.

1.4.2 Specific objectives

I. To evaluate the viral load response to ART at 6-9 months of starting treatment among CLHIV aged 5-19 years at nine BCC-supported clinics, January 2021-June 2023.

II. To identify the demographic and clinical characteristics associated with varying levels of viral load response in CLHIV aged 5-19 years initiated on ART at nine BCC clinics, January 2021- June 2023.

III. To analyze the adherence rates to ART among CLHIV aged 5-19 years on ART at nine BCC-supported facilities and their impact on viral load outcomes.

1.5 Research Questions

I. What are the viral load levels at 6-9 months of starting ART among children living with HIV aged 5-19 years at the nine BCC-supported clinics?

II. Which demographic and clinical characteristics are significantly associated with viral load response in CLHIV aged 5-19 years receiving ART at the nine BCC clinics?

III. What are the reported rates of adherence to ART among CLHIV aged 5-19 years, and how do these adherence rates correlate with viral load outcomes at the 6-9 months?

1.6 Assumptions

This study assumed that the medical records and laboratory results used to determine viral load levels were accurate and reliable, providing a valid basis for assessing health outcomes. In addition, the study assumed that the factors influencing viral load response will remain relatively stable over the study period (January 2021- June 2023), allowing for meaningful analysis and comparison.

1.7 Significance of the study

Understanding the factors that influence viral load response in CLHIV is critical for optimizing treatment protocols and improving health outcomes. The findings of this study can provide valuable insights for policymakers and healthcare providers in Zimbabwe. By identifying barriers to adherence and factors affecting treatment outcomes, the study can inform the development of targeted interventions and health policies aimed at improving ART adherence and viral load response among children.

In addition, the findings of the study can guide healthcare providers in tailoring care and support services to meet the specific needs of children on ART. Understanding the dynamics of adherence, healthcare access, and family support can lead to improved healthcare delivery models.

Furthermore, the study aligns with global health initiatives aimed at ending the AIDS epidemic among children by 2030. By focusing on viral load response and adherence in a specific context, the research contributes to broader efforts to achieve the United Nations Sustainable Development Goals (SDGs) related to health and well-being.

1.8 Delimitation of the Study

The following delimitations define the scope and boundaries of the study on the analysis of viral load response and associated factors in children aged 5-19 years living with HIV on ART in Bulawayo, Zimbabwe.

The study focused exclusively on children aged 5 to 19 years. This age range was chosen to capture experiences of both younger children and adolescents, recognizing that their needs and treatment challenges may differ from those of adults. The participants were CLHIV who were initiated on ART at the nine BCC-supported facilities namely, Nkulumane, Cowdray, Mzilikazi, NSC, EF Watson, Entumbane, Njube, Luveve and Nketa clinics and were eligible for baseline viral collection during the period January 2021- June 2023.

Children who were not initiated on ART treatment, those who were initiated on ART after June 2023 and those who were lost to follow-up, transferred out or died before completing six months post ART initiation were not be included in the analysis. The research was limited to Bulawayo, Zimbabwe. This delimitation allows for an in-depth analysis of local healthcare dynamics and socio-cultural factors affecting HIV management in this context. The study focused on viral load suppression as the primary outcome measure, defined as achieving less than 1000 copies/mL of HIV RNA.

1.9 Limitation of the Study

The major limitation to this study was that the researcher used a Retrospective study and it limits the ability to control for all confounding factors, and data quality may vary across records. Adherence measurement was not completely accurate as it was subject to self-reporting bias, where participants or guardians may underreport or overreport adherence to ART. The small sample size affects the generalizability of the

findings because the smaller cohort may not adequately represent the broader population of children living with HIV in Bulawayo.

1.10 Summary

This chapter looked at the introduction and background of the global, regional and local baseline viral load response post ART initiation in CLHUV. The problem statement and purpose of the study were discussed, objectives were identified and research questions that will answer and focus the study were discussed. The delimitations and limitations of the study were identified and addressed and also the importance of the study and the beneficiaries were discussed.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews the literature on viral load response amongst CLHIV on ART and the associated factors influencing treatment outcomes as well as the theoretical framework and how it relates to this study.

2.2 Theoretical Framework

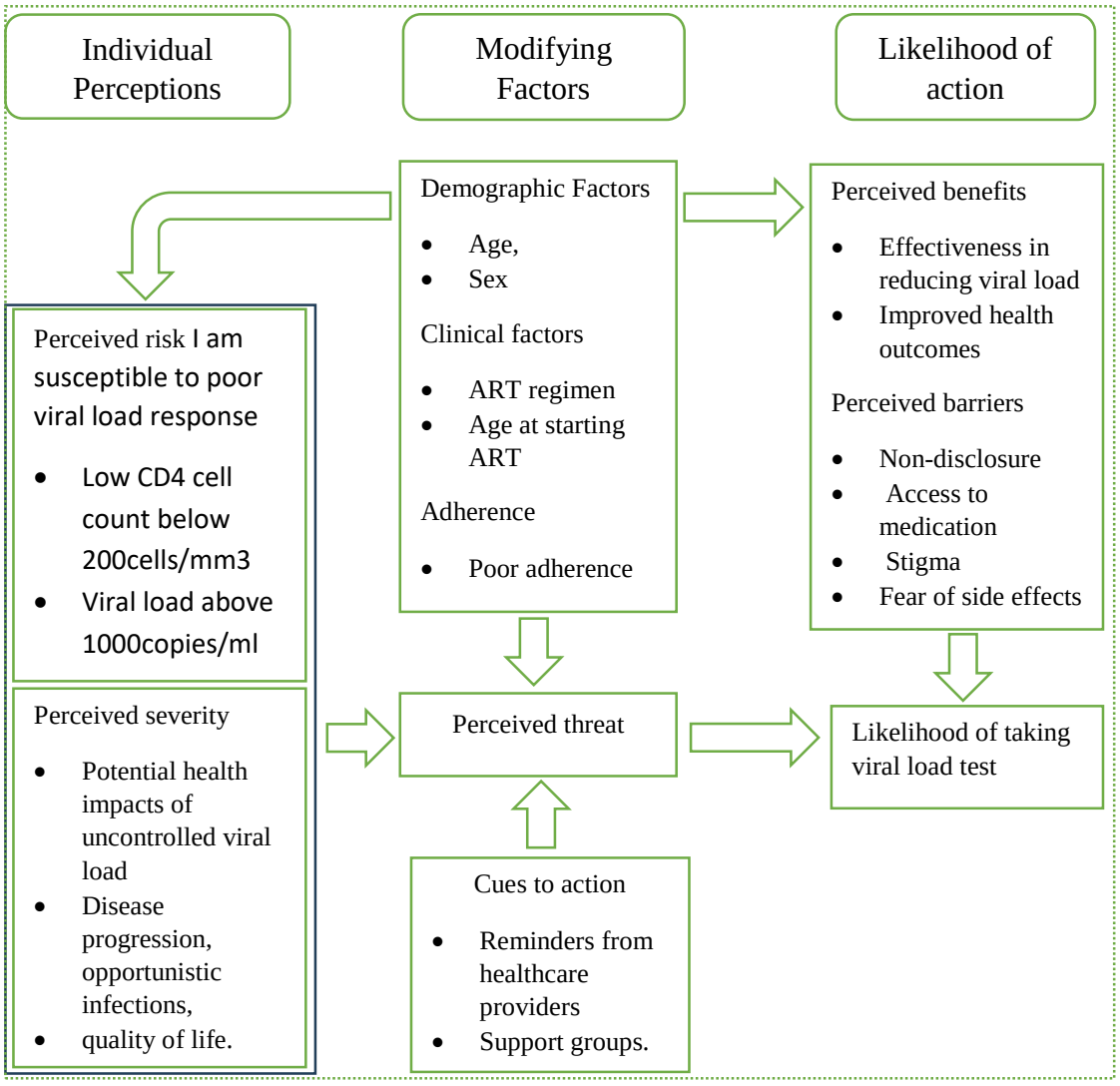

Figure 1: Health Belief Model adapted from Champion & Skinner (2008)

2.3 Relevance of the Theoretical Frame to the Study

Viral load response in CLHIV on ART is influenced by a complex interplay of factors, including adherence to treatment, socioeconomic status, caregiver support, age, viral load monitoring, ART regimen, and adherence factors.

The Health Belief Model (HBM) is a widely recognized theoretical framework in the analysis of health behavior. It was designed fifty years ago to understand the reasons behind the lack of motivation for disease prevention. Since its inception, the HBM has been used to clarify and predict behaviors associated with seeking and enhancing health. According to the HBM, people will only take steps related to their health if they think it will avert adverse health results. Elements such as an individual's perception of their susceptibility and the severity of a health condition are essential.

The HBM was chosen to examine barriers that affect access to services for the parents and guardians of children living with HIV. It assists in the identification of factors that influence access, risky behaviors, social influences, family factors, and individual characteristics. This model offers a framework to understand why people participate in, or refrain from, actions when they recognize a risk. The results can be used by stakeholders for advocacy, lobbying, and developing strategies to reduce the knowledge gap and decrease the chances of children on HIV ART being lost to follow-up.

2.4 Viral Load Response

Globally, an estimated 1.7 million children were living with HIV at the end of 2019, with significant disparities in treatment access and outcomes (WHO, 2020).A study by Mofenson et al., (2019) found a global average viral load suppression rate of 85% in children receiving ART, with variations based on geographical and socio-economic contexts. In high-income countries, viral suppression rates among children exceed

90% (Holt, 2021) whereas in sub-Saharan Africa, CLHIV achieve lower suppression rates, with only 70% of children achieving undetectable viral loads (McClure et al., 2020). In addition, Shung-King et al. (2019) found that only about 54% of children in LMICs achieve viral suppression affirming variation of viral load response across geographical regions.

Amongst the many regional studies examining viral load response in CLHIV, Kinyanjui et al. (2021) identified adherence, stigma, and access to healthcare services as key determinants of viral load suppression. This is consistent with the findings by Moyo et al. (2022) that highlighted the importance of psychosocial support in improving adherence among adolescents with HIV. In contrast, a study by Chikanda et al. (2021) noted that while adherence was a significant factor, genetic variations in the HIV virus contributed to the efficacy of ART.

In Zimbabwe, the national ART program has made significant strides in its response to HIV epidemic including viral load monitoring, challenges remain. Ncube et al. (2022) found that 75% of CLHIV on ART attained viral suppression, indicating improvements in treatment access and adherence strategies. Nonetheless, the study noted urban-rural disparities, with rural areas facing more challenges to healthcare access. Importantly, Dube et al. (2023) noted that in Bulawayo, only 60% of children aged 5-19 years receiving ART attained viral load suppression. Factors contributing to the lower rate included inadequate healthcare infrastructure, stigma, and lack of family support. This suggests that there is need for adaptation of national policies to suit local context.

Furthermore, a quantitative analysis by Chibanda et al. (2023) demonstrated that adherence rates were significantly lower in adolescents than in younger children, highlighting a developmental gap in support systems. This is consistent with the

findings of McClure et al. (2020) suggesting that the transition from childhood to adolescence represents a crucial phase requiring targeted interventions to maintain viral load response.

The literature demonstrates that ART is effective in achieving viral load suppression in CLHIV, however, significant disparities in viral load response exist depending on geographical location, socioeconomic status and cultural influences.

2.5 Suppression Rates

2.5.1 Viral Load Suppression Rates

Various studies indicate that viral load suppression is often higher in females than in males, while some studies have reported contrasting findings where males achieve higher suppression rates.

A study in Thailand by Puthanakit et al. (2016) indicate that while both genders demonstrated significant viral load suppression, males showed somewhat higher rates of viral load suppression than females, with 80% of males obtaining undetectable viral load compared to 75% of females. This could be attributed to variations in adherence to treatment, as males were reported to have better adherence rates.

Similarly, in a study conducted in Sub-Saharan Africa findings show that in specific contexts, males achieved higher viral load suppression rates than females attributed to higher optimal adherence rates especially where male engagement in healthcare is prioritized (BMC Infectious Diseases, 2025). Likewise, findings from a study in Harare, show that males had higher viral load suppression rates than females due to better adherence and engagement in their care (Bvochora et al., 2019).

Furthermore, Geng et al. (2018) observed that females often face unique social and economic barriers that can affect their access to healthcare and adherence. Due to increased likelihood of stigma and discrimination, females are less likely to seek

treatment and maintain adherence leading to lower viral suppression rates compared to males.

However, a systematic analysis by (BMC Infectious Diseases, 2025) argues that females achieve better viral load suppression rates than males, particularly if ART is commenced at comparable CD4+ levels. This indicates that females may show a more positive response to ART as a result of their biological structure. Chikwari et al. (2021) concur that females had a higher rate of viral load suppression than males, emphasizing the importance of caregiver support and the impact of social determinants on treatment outcomes.

Correspondingly, Moyo et al. (2021) found that female children had a significantly higher rate of viral load suppression than males, with 95% of females achieving undetectable viral load compared to 88% of males.

In conclusion, the literature indicates that gender significantly influences viral load response in CLHIV on ART, with females generally achieving higher rates of viral load suppression than males in many contexts. However, there are notable exceptions where males have higher viral suppression rate than females, highlighting the complexity of gender dynamics in HIV treatment and the need for tailored interventions.

2.5.2 Treatment Optimization Rates

Research conducted on a global scale has revealed major differences in adherence levels to ART across different genders. Geng et al. (2016) observed that males often show greater adherence rates (82%) for 5 to 14 years compared to the low adherence of 74% for their female peers. The researchers believed that societal norms and expectations could play a significant role in these disparities, arguing that males often receive more support to participate in healthcare activities. Similarly, Nachega et al.

(2015) found that females often face greater social stigma and barriers to healthcare access, affecting their ability to adhere to treatment. This literature emphasizes the importance of gender-sensitive programs to improve treatment optimization rates among girls.

In contrast, Chikanda et al. (2021) reported that targeted interventions targeting females, such as educational programs and peer support groups, significantly improved adherence rates. Their findings demonstrated a 15% increase in adherence among females over two years, demonstrating the value of gender-responsive measures in promoting ART adherence.

Furthermore, Ncube et al. (2022) found that females often face unique challenges such as early marriage and family responsibilities that may affect adherence. The study also noted that females who took part in community support programs had a 35% higher chance of adhering to ART than those who did not. This finding highlights the importance of addressing the social determinants of health to improve treatment optimization rates among girls.

Moreover, a community-based intervention by Sibanda et al. (2023) established that females who attended peer support groups and individualized educational programs showed a 20% increase in adherence rates compared those who did participate. The connection between targeted interventions and increased adherence highlights the urgent need for gender-sensitive healthcare interventions to address the unique challenges faced by CLHIV.

2.6 Age

2.6.1 Viral Load Response Breakdown by Age

Age plays a vital role in influencing the viral load response among CLHIV on ART. Generally, children have stronger immune response, that may enhance their ability to

suppress viral replication when receiving ART. The psychosocial environment in older children and adolescents might greatly influence treatment adherence and, subsequently their viral load response. In addition, factors such as family support, peer influence, and access to healthcare resources are critical in determining the effectiveness of ART in these age groups (Szubert et al., 2017).

Globally, research has shown that age plays a significant role in the viral load response of children on ART. Kuo et al. (2021) found that younger children (0-5 years) had higher rates of viral load suppression than older children and adolescents (10-19 years). The study established that 90% of younger children had undetectable viral load, compared to 70% of adolescents. This difference is most likely due to factors such as adherence challenges, transition, and psychological factors affecting older children.

In addition, Khamis et al. (2022) noted that adolescents face challenges such as stigma and mental health that affect adherence, subsequently affecting viral load response. The study showed that 65% of adolescents achieved viral suppression, reinforcing the importance of targeted interventions for this age group.

This literature analysis demonstrates that ART is successful, but age-related issues must be addressed to improve outcomes. Similar findings were observed in a study conducted in Bulawayo by Chibanda et al. (2023), where 50% of adolescents achieved viral load suppression compared to 75% in younger children, indicating a developmental difference in support systems. This finding is consistent with broader trends noted in both regional and global studies, emphasizing the need for age-appropriate support systems.

However, Chikanda et al. (2021) discovered that, while younger children have better viral load response, the gap is narrowing as more adolescents gain access to psychosocial support and adherence programs. The study found a 10% improvement

in viral suppression rates among adolescents over the past five years, indicating that targeted interventions can improve outcomes for older children.

Furthermore, Ncube et al. (2022) found that the transition from childhood to adolescence is critical and requires specific strategies to maintain viral load response. Adolescents who received psychological support were 30% more likely to achieve viral suppression compared to individuals who did not. This relationship highlights the importance of comprehensive treatment strategies that address both medical and psychological needs. The literature shows that ART is effective in achieving viral suppression in CLHIV, however there are significant differences depending on age, geographical location, socioeconomic status, and developmental stages.

2.6.2 Treatment Optimization by Age

Adherence to ART is a complex issue influenced by a number of factors, including age. Younger children often report higher adherence rates, whereas adolescents face multiple challenges that affect their adherence to ART. Haberer et al. (2017) observed that children aged 6–12 years had higher adherence rate (85%) than adolescents (58%) because they mostly depend on their caregivers for emotional and psychological support. Studies further show that CLHIV with knowledgeable and supportive guardians are more likely to adhere to their treatment (Xu et al., 2017).

Similarly, Dube et al. (2023) in Bulawayo observed differences in adherence rates among CLHIV on ART with younger children reporting 75% adherence and 55% for adolescents who adhered to their treatment because of direct guardian support. Another study by Kuo et al. (2021) supported these findings, highlighting that adolescents are more likely to face challenges such as stigma and mental health issues, which may have a major impact on treatment optimization.

While adherence remains low among adolescents, Chikanda et al. (2021) found that community participation and peer support programs have the potential to improve adherence rates. Their study found an increase of 15% in adherence rates among adolescents over a three-year period, demonstrating that individualized strategies may improve adherence. From the literature, treatment optimization rates vary significantly by age. Younger children are likely to achieve higher adherence rates than adolescents, who experience various challenges to adherence.

2.7 Disclosure status

2.7.1 Viral Suppression by Disclosure Status

Partial disclosure entails informing young children about their HIV status in a developmentally appropriate manner. The process emphasizes communicating essential medical facts without overwhelming individuals with their medical condition. Partial disclosure can lessen psychological stress for younger children while increasing their understanding about their health needs. Children who are not fully aware of their disease may not understand the importance of constantly taking their medication (Finnegan et al., 2019). However, if the process of partial disclosure is not done properly, younger children may be at risk of non-adherence due to lack of understanding on the importance of their treatment.

Full disclosure for adolescents involves offering comprehensive information on their HIV status, including the health consequences and the importance of adherence to ART. Globally, research shows that full disclosure is associated with better health outcomes for adolescents. A systematic review discovered that adolescents who are informed of their HIV status are more likely to adhere to ART and achieve viral suppression than those who are not aware of their HIV status (Finnegan et al., 2019).

In terms of disclosure and viral load response, research shows that disclosure of HIV status is associated with better viral load outcomes. Nachega et al. (2015) found that children who disclosed their HIV status had a 78% viral load suppression rate, as opposed to 56% for those who did not disclose their HIV status.

Similarly, Mavhandu-Mudzusi et al. (2019) observed that adolescents in South Africa who disclosed their HIV status had higher optimal adherence rates, with 72% viral load suppression compared to 48% in non-disclosers. The study attributed this difference to the increased support and monitoring received by CLHIV who were open about their status, suggesting that disclosure improves treatment success.

On the contrary, Chikanda et al. (2021) found that while disclosure is beneficial, cultural factors can affect the willingness to disclose. The research noted that adolescents from communities with high levels of stigma were less likely to disclose their status, which had a negative effect on their adherence and viral load response.

In conclusion, evidence shows that disclosure of HIV status has a significant impact on viral load response in CLHIV with those that disclose their HIV status having better treatment outcomes. Barriers, such as stigma and cultural can affect the disclosure process resulting in poor adherence to ART and low viral load suppression.

2.7.2 Treatment Optimization by Disclosure Status

Worldwide, research has shown that the age at which children disclose their HIV status has a major impact on adherence rates. Dube et al. (2023) noted that among CLHIV aged 5 to 19 years who had disclosed their HIV status, adherence rate was 68% compared to 52% for those children with non-disclosure of HIV status. Older adolescents were more likely to understand the importance of adherence. The study highlights the important role of education and support systems in promoting disclosure and improving adherence.

McMahon et al. (2016) discovered that younger children often face difficulties with disclosure due to lack of knowledge and a fear of stigma. According to the review, non-disclosure was associated with a 40% treatment optimization rate, particularly among children aged 5 to 9 years. This critique emphasizes the importance of age-appropriate interventions that address specific problems that younger children face regarding disclosure and adherence.

Puthanakit et al. (2016) observed that older children (ages 10-19) who disclosed their HIV status had 75% adherence rates, compared to 60% in non-disclosure. The research suggests that older children who have disclosed their HIV status are better able to understand their disease and the importance of ART, resulting in higher treatment optimization rates. Likewise, Ndung'u et al. (2020) found that adolescents who disclosed their HIV status had a 70% adherence rate, compared to 50% of their counterparts who did not disclose their status.

In conclusion, the literature shows that the disclosure of HIV status significantly influences treatment optimization among CLHIV, with older children generally reporting higher adherence rates compared to younger ones. However, barriers such as stigma and lack of understanding can affect disclosure, particularly in younger age groups.

2.8 Caregiver Status

2.8.1 Viral Suppression by Caregiver Status

Understanding how different caregiver relationships influence treatment outcomes is critical, particularly for children aged 5 to 19 years on ART.

Bikaako-Kajubi et al. (2016) established that children whose primary caregivers were their biological parents had a 78% viral load suppression rate, compared to 63% for those cared for by extended family members or non-relatives. Similarly, a study

conducted in Bulawayo by Dube et al. (2023) found that children with biological parents as caregivers had a 70% viral load suppression rate, compared to 45% for those cared for by non-parental guardians. The findings show that parental involvement normally translates to better adherence because of improved emotional support and understanding of the treatment plan.

Likewise, Nachega et al. (2016) found that children living with non-parental caregivers, such as grandparents or guardians, had lower adherence and poorer health outcomes. The analysis found that emotional and educational support from biological parents was often lacking in these relationships, culminating to a 30% decrease in viral load suppression.

On the other hand, Ridgeway et al. (2018) found that non-biological parents, such as grandparents or aunts and uncles, often assume caregiving responsibilities, such as managing medication schedules and attending medical appointments. As such, CLHIV with active involvement of non-biological parents in their healthcare were more likely to achieve higher viral load suppression. In addition, Sibanda et al. (2023) concurs that educational programs aimed at improving HIV knowledge among both parents and extended family members significantly improved adherence rates, resulting in a 30% increase in viral load suppression among children whose caregivers participated in educational initiatives, showing the benefits of including the broader family network in HIV care.

The literature demonstrates that the relationship between CLHIV on ART and their caregivers has a significant impact on adherence to ART and viral load response. Children living with their biological parents have better health outcomes than those under non-parental care. However, supportive extended family structures may improve adherence, resulting in improved viral load suppression rates.

2.8.2 Treatment by Caregiver Status

Caregiver involvement in HIV management is a strong predictor of ART adherence. Bikaako-Kajubi et al. (2016) found that children whose caregivers were biological parents had an adherence rate of 80%, compared to 60% for those under the care of extended family members. The study noted that parental involvement often leads to stronger emotional support and an understanding of ART, resulting in better health outcomes.

Likewise, Mavhandu-Mudzusi et al. (2019) found that children living with their biological parents had significantly higher adherence rates (75%) compared to those living with other relatives (50%). The findings are attributed to the stronger emotional and support provided by biological parents.

While children living with extended family members often face stigma and lack of knowledge about HIV affecting their treatment optimization, Ncube et al. (2022) argues that when caregivers are informed on the importance of ART, adherence rates improve. This critique emphasizes the need of educational programs that include both parents and extended family members.

In summary, literature shows that CLHIV with biological parents have better health outcomes than those in non-parental care. However, supportive extended family structures can improve treatment optimization rates, especially when caregivers are educated about HIV.

2.9 Orphan status

2.9.1 Viral Suppression by Orphan Status

Orphan status has been found in several studies in Africa to have an impact on CLHIV health outcomes. A study in Uganda by Musinguzi et al. (2020) established that double orphans had a viral load suppression rate of 60%, compared to 72% for single orphans

and 80% for non-orphans suggesting that double orphans often lack stable support systems, which affect their adherence.

Dube et al. (2023) reported comparable findings in Bulawayo, with double orphans having a viral load suppression rate of 50%, compared to 65% for single orphans and 75% for non-orphans. Double orphans often experience challenges such as stigma, lack of emotional support, and financial constraints, all of which contribute to lower adherence rates and thereby affecting viral load suppression. Furthermore, Cluver et al. (2016) discovered that double orphans were 1.5 times more likely to have poor adherence than single orphans, largely due to the absence of both parents and the resultant instability in their home environment, leading to lower viral load suppression in double orphans.

However, Wamala et al. (2021) found that, while single orphans are still at risk of poor adherence and lower viral load suppression, they are more likely to have better adherence and achieve higher viral load suppression when they have a stable caregiver. The study concluded that single orphans living with supportive family had adherence rates above 70%, resulting in a higher viral load response and affirming the protective role of caregiver support. This association stresses the importance of involving caregivers into treatment strategies for orphans to improve viral load suppression.

2.9.2 Treatment by Orphan Status

According to Vreeman et al. (2013), double orphans had lower adherence rates (54%) than single orphans (75%), and non-orphans (80%). These differences are attributed to the various challenges faced by double orphans, including psychological factors and a lack of stable support systems impacting on their ability to adhere to treatment.

Similarly, Kakuhikire et al. (2015) and Mugisha et al. (2017) observed that double orphans had significantly lower adherence rates than single orphans and non-orphans. Double orphans had a reported adherence rate of 58% contrary to 80% for non-orphans, demonstrating the negative impact of losing both parents (Kakuhikire et al., 2015).

On the other hand, Wamala et al. (2021) argue that while orphans are still at risk of poor adherence, they are more likely to adhere when they have a stable caregiver. The study showed that single orphans living with supportive family had adherence rates that above 70%, demonstrating the protective role of caregiver support. On a similar note, Shisana et al. (2014) observed that single orphans living with supportive family members had adherence rates comparable to those of non-orphans. These findings suggest that, while being orphaned presents challenges, the quality of the caregiver environment has a major impact on health outcomes.

In summary, literature analysis suggests that, orphan status has a significant impact on ART adherence in CLHIV. Double orphans often have lower treatment optimization rates than single orphans because of the lack of consistent support structures. However, having a supportive caregiver can help to mitigate some of the negative effects of being an orphan.

2.10 Viral Suppression by Treatment Regimen

The type of ART regimen used influences the degree to which antiretroviral therapy acts in treating HIV. The comparative analysis of ART regimens reveals significant variations in viral load response among CLHIV. While DTG-based regimens consistently demonstrate higher viral suppression rates, older regimens like Lopinavir, Efavirenz, and Nevirapine have shown mixed results

Okwera et al. (2021) found that children on DTG had fewer treatment failures compared to CLHIV on Efavirenz and Nevirapine. These findings imply that, while older regimens are still effective, the introduction of DTG has changed the landscape of HIV treatment in children. Similar findings were noted in a comprehensive study by Kacanek et al. (2020), who found that children on DTG-based regimens achieved viral suppression rates of 90% compared to 70% on Lopinavir-based regimens. The findings attributed the achievement of high viral load suppression to the favourable pharmacokinetics and high barrier to resistance of DTG.

Furthermore, Dube et al. (2023) found that DTG-based regimens resulted in 85% viral load suppression rate among CLHIV, which was much higher than the 65% achieved with Efavirenz-based regimens. The variations in viral load suppression were attributed to the efficacy of DTG and fewer drug interactions, making it more appropriate for children with varying health conditions. Moreover, Peluso et al. (2020) discovered that children on ART regimens containing DTG had a more favourable immunological response, which was associated with better viral load outcomes. This shows that the choice of ART regimen influences not just viral load but also overall immunological health in CLHIV.

While lopinavir/ritonavir (LPV/r) has been the cornerstone of ART for children, its effectiveness may be limited by factors such as adherence and side effects. Violari et al. (2019) noted that children on Lopinavir-based regimens had a viral load suppression rate of around 70%, which was lower than that reported for DTG, indicating that, while Lopinavir is successful, it may not be the best choice for long-term treatment in children.

Similarly, efavirenz and nevirapine have been widely used in CLHIV, however their efficacy varies. Mofenson et al. (2020) found that children on Efavirenz-based

regimens had a viral load suppression rate of 65%, nonetheless, there were concerns regarding neuropsychiatric side effects and the need for accurate dosing in children limit its use. The observed superiority of DTG-based regimens in terms of viral load response implies that healthcare providers should prioritize these regimens when managing CLHIV.

2.11 Viral Suppression by Adherence Level

Adherence to ART is critical in HIV management to maintain sustained viral suppression while improving health outcomes. WHO defines optimal adherence as taking at least 95% of the prescribed doses, while suboptimal adherence ranges from 80% to 94% (WHO, 2016). Adherence levels are directly linked to viral suppression. Kagee et al. (2018) investigated the impact of optimal adherence on viral load outcomes in CLHIV in different countries, including South Africa and Kenya.

The study found that children with optimal adherence (≥95%) had a viral suppression rate that was higher than 90%. This was attributed to strong caregiver support, regular follow-ups, and effective health education programs. Similarly, Kacanek et al. (2020) investigated adherence and viral load response among children on ART in LMICs and discovered that children with optimal adherence consistently achieved viral load suppression rates above 90%, reinforcing the notion that high adherence levels are critical for effective HIV management.

Furthermore, Agbaji et al. (2019) found that children with suboptimal adherence had a viral load suppression rate of around 70%. The study observed various barriers to adherence such as stigma, a lack of caregiver support, and complex dosing regimens. All of these factors contributed to inconsistent medicine intake, ultimately affecting viral load outcomes. Moreover, Mshana et al. (2021) discovered that suboptimal adherence was widespread among adolescents, with only 65% achieving

viral suppression. The transition from peadiatric to adult care often resulted in decreased adherence due to changes in support systems and increased independence. This transition period is critical, and targeted interventions are needed to support adherence.

The reviewed studies show a strong correlation between adherence levels and viral load response among CLHIV. Optimal adherence is associated with high rates of viral suppression, while suboptimal adherence significantly affects treatment success.

2.12 Summary

This chapter outlines the theoretical framework for viral load response in Children Living with HIV, identifies gaps in the existing literature and details literature findings on factors that may be associated with viral load response as the determinants influencing the response to ART.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter describes the study setting, study population, study period together with the sample size and the sampling techniques that were used. The data collection tools that were utilised and the methods of data analysis that are were employed are also detailed in this chapter. Ethical considerations are also stated.

3.2 The Research Design

This study utilised a retrospective cohort approach. Sanctis et al. (2022) define a retrospective study as a type of observational research that involves analysing existing data to investigate outcomes that have already occurred. This design typically reviews historical records, such as medical charts or databases, to assess events of interest and their associations with various factors. As such, this study reviewed medical records from January 2021 to June 2023. The researcher extracted and analysed data from the medical records of children aged 5-19 years living with HIV who have been on ART for at least 6 months at selected healthcare facilities in Bulawayo to assess viral load responses and associated factors among children aged 5-9 years living with HIV on ART in Bulawayo.

3.3. Study site

The study was conducted in Bulawayo, one of the ten provinces of Zimbabwe and serves as the country's second-largest city. It is located in the western part of Zimbabwe and is known for its historical significance and industrial base. Bulawayo is one of the smaller provinces in Zimbabwe encompassing the city of Bulawayo which covers an area of approximately 1,200 square kilometers. The province is characterized by urban, semi-urban, and rural areas, contributing to its diverse landscape and demographics. According to the latest data from the Zimbabwe National

Statistics Agency (ZIMSTAT, 2022), the estimated population of Bulawayo Province as of the 2022 Population and Housing Census is approximately 665,940. Bulawayo is characterized by a significant urban population, with many residents migrating from surrounding rural areas in search of better economic opportunities.

The province has a mix of health institutions, including public clinics operated by the Bulawayo City Council, private hospitals, non-governmental organizations (NGOs), and faith-based organizations, all of which contribute to the healthcare landscape in the city. Bulawayo City Council clinics play a crucial role in the provision of paediatric antiretroviral therapy (ART) and viral load monitoring for children and adolescents living with HIV.

Paediatric ART was officially rolled out in Zimbabwe in 2004, with Bulawayo being one of the key locations for implementing these services. Bulawayo city clinics have a population of CLHIV on ART of 1875 which constitutes 56% of total number of CLHIV on ART in Bulawayo. The nine BCC clinics namely Nkulumane, Cowdray Park, Mzilikazi, Northen Suburbs Clinic (NSC), Entumbane, Njube, Luveve, Nketa and EF Watson clinics were because they have the highest proportions of CLHIV in the BCC supported facilities.

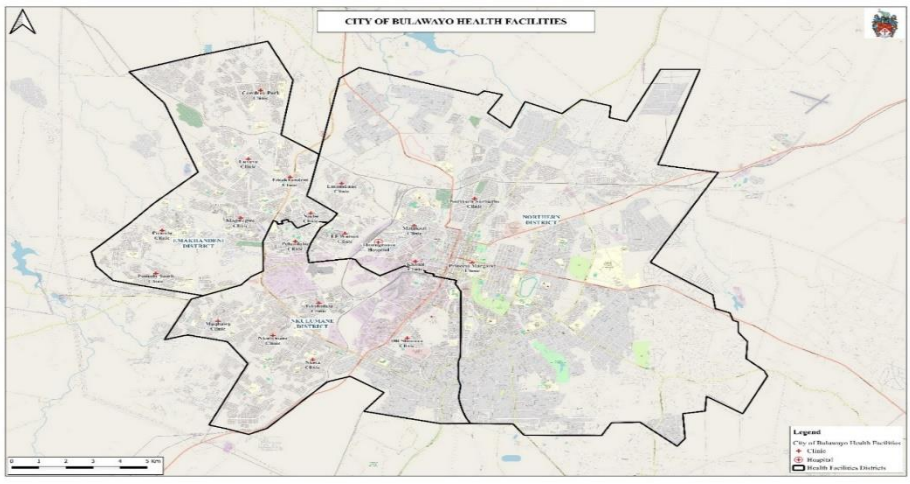

Figure 2: City of Bulawayo Health Facilities

3.4 Study population

The study targeted CLHIV aged 5-19 years registered and received ART for at least 6 months at Nkulumane, Cowdray, Mzilikazi, NSC, EF Watson, Entumbane, Njube, Luveve and Nketa clinics during the period January 2021- June 2023. This age group is critical as it encompasses the transition from childhood to adolescence, a period often associated with unique challenges in HIV management (WHO, 2021).

3.4.1 Inclusion criteria

- CLHIV aged 5-19 years registered and receiving ART at Nkulumane, Cowdray, Mzilikazi, NSC, EF Watson, Entumbane, Njube, Luveve and Nketa clinics during the period January 2021-June 2023.
- CLHIV who have been on ART for a minimum of 6 months and were eligible for viral load collection at six to nine months post ART initiation.

3.4.2 Exclusion criteria

- CLHIV on ART below the age of 5 years.
- Children not registered and receiving ART at Nkulumane, Cowdray, Mzilikazi, NSC, EF Watson, Entumbane, Njube, Luveve, Pelandaba and Nketa clinics.
- CLHIV initiated on ART at the nine BCC-supported clinics after June 2023.
- CLHIV who are lost to follow up, transferred out and those that died before viral load collection at six months of ART initiation.

3.5 Study period

The secondary data analysis focused on CLHIV initiated on ART between the period 1st January 2021 to June 2023.

3.6 Sample size and sampling techniques

Calculating an appropriate sample size is crucial for ensuring that the study findings are statistically valid and can be generalized to the population. The most appropriate

sampling method for selecting medical records of CLHIV on ART was stratified random sampling. This method allows for a more representative sample by ensuring that specific subgroups within the population are adequately represented. The population of CLHIV aged 5-19 years is likely to be diverse in terms of age, gender, clinical status, and adherence levels. Stratified random sampling enables researchers to divide the population into distinct subgroups (strata) based on these characteristics, ensuring that each subgroup is represented in the sample. This approach enhances the representativeness and precision of the findings related to viral load response and associated factors.

The minimum required sample size was determined using the formula recommended by (Hlophe et al, 2023).

The most appropriate method for calculating the sample size for medical records of CLHIV on ART is Cochran's formula. This statistical method is widely used for determining sample sizes in health research, particularly when dealing with proportions.

$$n = \frac{Z^2.P(1-P)}{E^2}$$

Where:

- n is the sample size
- Z is the value corresponding to the desired confidence level
- P *is the* estimated population proportion
- E *is the* margin of error
- Determine the Proportion (p)**:** The p-value was calculated using the findings from previous studies showing that viral load suppression amongst CLHIV on ART is 85% (MoHCC, 2021). Therefore, p-value is 0.85.

- Select the Confidence Level (Z)**:** Commonly, a 95% confidence level is used, which corresponds to a Z-value of 1.96.
- Decide on the Margin of Error (e)**:** This is the acceptable difference between the sample estimate and the true population value, often set at 5% (0.05).
- Calculate the Sample Size: Plug the values into Cochran's formula to obtain the required sample size.

Plugging these values into the formula:

$$n = \frac{1.96^2 . 0.85(1 - 0.85)}{0.05^2}$$

$$n = \frac{3.8416.0.25.0.15}{0.0025}$$

$$n = \frac{0.48936}{0.0025}$$

n= 195.744

Thus, the minimum sample size needed was 196. We anticipated a non-response rate of 10% to enable us to calculate the maximum sample size.

Maximum sample size = $\frac{minimum\ sample\ size}{Response\ rate}$

$= \frac{196}{0.9}$ = 217.8 = 218

Therefore, the sample size was between 195 and 218

3.7 Data Collection Instruments

The study used secondary data from patient OI/ART booklets and Electronic Health Records (EHR). Approval for data access was sought from relevant authorities, and confidentiality was maintained throughout the research process. A structured data extraction form was developed to capture relevant clinical data from existing medical records, including demographics, ART regimen, adherence history, and viral load measurements.

Data Extraction was done by nurses working at OI departments who were trained as research assistants. They systematically reviewed the medical records and extracted relevant data using a standardized excel form. Data verification was done a by secondary reviewer to ensure accuracy. The second reviewer cross-checked a random sample of the extracted data against original medical records.

Data points that were collected included the independent and dependent variables. The dependent variable comprised of viral load response, date of viral load testing and viral load results (copies/ml). Independent Variable factors included demographic information such as age and gender. In addition, clinical information such as HIV diagnosis date, ART regimen details which include type of drugs and adherence levels inferred from medical records was collected as dependent variables.

With regards to data management, database was created, the collected data was entered into an excel which is a secure electronic database. All personal identifiers were removed to maintain confidentiality and anonymity**.**

3.8 Data extraction procedure

Authority was sought from Bulawayo City Health Directorate to utilise the Electronic Health Records (EHR) system and Patient OI/ART booklets for the purposes of research. The variables extracted from the EHR system and Patient OI/ART booklets for the purposes of the study were the unique patient identifier, province, facility, age, gender, socioeconomic status, ART regimen, date of ART initiation, viral load measurements, adherence indicators, disclosure, caregiver and orphan status.

Data extraction was conducted in a systematic manner. Medical Records were reviewed to extract relevant information from patient files, ensuring that each variable is consistently recorded. EHR system was utilised to streamline data extraction, facilitating quicker access to patient information. Any difficulties encountered during

the extraction process, such as missing data or discrepancies in records were documented.

Data verification process was done to ensure the accuracy of the extracted data. This was achieved by cross-checking a sample of extracted data against the original records. In addition, any discrepancies were resolved through discussion with healthcare providers and additional record reviews.

3.9 Pretesting tools

Pretesting of data extraction tool, extraction procedures and data collection procedures were done through reviewing data from 10 patient OI/ART booklets (Green books) for CLHIV on ART for more than 6 months, registered and initiated on ART in January 2024 at Princess Margaret Rose Clinic in Bulawayo.

3.10 Data management and analysis

Data collected was inputted in a secure Microsoft excel ensuring that all entries are anonymized to protect patient confidentiality. The Microsoft excel was reviewed and cleaned for errors, duplicates, and missing values. In terms of missing data, complete case analysis by variable was employed. The data was stored in a secure environment with regular backups to prevent loss.

Statistical Package for the Social Sciences (SPSS) was used for statistical analysis, data management, and data documentation. It allows users to easily import, manipulate, and manage large datasets. It supports various data formats, including Excel, CSV, and SQL databases. In addition, the software provides a wide range of statistical tests and procedures, including descriptive statistics, inferential statistics, regression analysis, ANOVA, and non-parametric tests.

Univariate analysis is a statistical technique that involves the examination of a single variable to summarize and understand its characteristics. The primary goal is to

describe the data and identify patterns or trends within that variable, without considering the relationships between multiple variables. Univariate analysis was used to provide descriptive statistics such as mean, median, mode, range, and standard deviation to summarize demographic data such as, age, gender and orphan status.

Bivariate analysis is a statistical method used to examine the relationship between two variables. It helps researchers understand how one variable may affect or correlate with another. This type of analysis can be descriptive or inferential, and it often involves calculating correlation coefficients, conducting regression analysis, or using contingency tables to explore the associations between the variables. In this study Bivariate analysis was used to identify and understand the factors associated with viral load suppression among CLHIV on ART.

Bivariate analysis helped to identify relationships between demographic factors such as age, sex, caregiver status, adherence and clinical outcomes such viral load suppression. In addition, the analysis was used to evaluate how adherence to ART impacts on viral load outcomes. This was done by comparing adherence levels with viral load results to determine if there is a significant association between these two variables. Furthermore, bivariate analysis was be used to assess the relationship between ART regimen and the likelihood of achieving viral load suppression. This was important to identify which treatment regimens are more effective for CLHIV. Above all, using bivariate analysis, the study was able to employ statistical tests such as chi-square tests for categorical variables that were used to determine if the observed associations are statistically significant, thereby providing insights into which factors are most influential in achieving viral load suppression.

3.11 Dissemination of results

The study findings were shared with Africa University and the City of Bulawayo Health Services Department.

3.12 Ethical Consideration

Permission to conduct the study and to utilise the EHR system and Patient OI/ART booklets was sought from the Bulawayo City Health Services Directorate. The data extracted from Patient OI/ART booklets and EHR was de-identified and kept confidential in a password protected folder and password protected laptop. The research complied with data protection laws and ethical guidelines for research involving human participants. The research proposal was submitted to the Institutional Review Board (IRB) or relevant ethical committees for approval by Ethics Committees.

3.13 Summary

This chapter detailed the study methodology that was utilised by describing the study design, study setting, population under study, sampling technique to be used, data collection tools and procedure and data analysis together with ethical considerations that guided the study.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the findings of the secondary data analysis and the interpretations. Univariate and bivariate analysis were conducted to analyse viral load response to ART, identify factors associated factors as well the effect of adherence to viral load outcomes.

4.2 Data presentation, analysis, and interpretation

4.2.1 Analysis and Interpretation of Participant Characteristics

The median age of participants was 18 years, with an interquartile range (IQR) of 15–19 years. This suggests that most participants were in late adolescence, with half of them aged between 15 and 19 years. The majority of participants were females (79.4%), while males constituted 20.6%. This indicates a significant gender imbalance in the study sample, which may reflect differences in healthcare access and survival rates. Most participants (75.9%) fall within the 15–19 years category.

The 10–14 years group represents 15.6%, while the 5–9 years group accounts for only 8.5%. This skewed distribution suggests that older children and adolescents form the bulk of the study population, possibly due to better survival on ART or targeted interventions for older age groups. 78.9% of participants are classified as "Not Applicable," because they were 15 years and above. 3.5% are single orphans and 2.5% are double orphans.15.1% have their orphan status not indicated, which points to missing data. The study population is predominantly female and in late adolescence (15–19 years old).

The number of orphans (single or double) is relatively low, but missing data on orphan status could affect interpretations. Further analysis is needed to explore whether

gender, age, or orphan status influence viral load response and treatment outcomes (Table 1).

Table 1: Participant Characteristics

Characteristic variable (N=199)	**Participants n (%)**
Age median (IQR)	18(15– 19)
Interquartile range	
Q1	15
Q3	19
Gender	
Female	158(79.4)
Male	41(20.6)
Age group	
5– 9	17(8.5)
10 – 14	31(15.6)
15 – 19	151(75.9)
Orphan status	
Not Applicable	157(78.9)
Single	7(3.5)
Double	5(2.5)
Not indicated	30(15.1)

4.3 Viral Load Response

Majority of participants (148 participants, 74.4%) achieved viral suppression suggesting that treatment or intervention was effective for most individuals, however, it is below the 95% target by UNAIDS. This is a positive outcome and may indicate strong adherence to ART or effective healthcare support. A smaller portion of the population (24 participants, 12.1%) did not achieve viral suppression This could highlight challenges such as issues with adherence and resistance to medication. 27 participants (13.6%) were missed. These participants did not have their viral load measured or reported despite being active on treatment. This reflects gaps in patient follow-up, which could impact the overall conclusions of the study (Table 2).

Table 2: Viral Load response

Characteristic variable	Participants N=199 n (%)
Viral load response	
Suppressed	148(74.4)
Unsuppressed	24(12.1)
Missed	27(13.6)

Viral load suppression Rates

Males had a viral suppression rate of 68.3%, while 17.1% were unsuppressed, and 14.6% had missing data. Females had a viral suppression of 75.9%, 10.8% were unsuppressed, and 13.3% had missing data. Suppression is higher among females (75.9%) compared to males (68.3%), but the difference is not statistically significant. A higher percentage of males (17.1%) had unsuppressed viral load compared to females (10.8%), suggesting that males might face greater challenges in adherence, treatment response, or healthcare access. The missing viral load data is similar between males (14.6%) and females (13.3%), indicating potential issues with follow-up or data completeness in both groups. Statistical Significance is ($p = 0.503$). Since $p = 0.503$ (>0.05), the difference between males and females is not statistically significant. This means gender alone does not strongly influence viral load suppression in this sample. While viral suppression appears slightly higher in females (75.9%) than males (68.3%), this difference is not statistically significant. The higher percentage of unsuppressed males (17.1%) may warrant further investigation into gender-specific adherence barriers or biological differences in ART response. Further analysis by age groups, orphan status, and adherence levels could provide deeper insights into the factors affecting viral load response (Table 3).

Table 3: Viral Load Suppression Rates

Characteristic variable	Suppressed N=148 n (%)	Unsuppressed N=24 n (%)	Missed N=27 n (%)	P value
Gender				
Male	28(68.3)	7(17.1)	6(14.6)	0.503
Female	120(75.9)	17(10.8)	21(13.3)	

Shows findings are statistically not significant (p>0.05)

4.3.2 Treatment Optimization Rates

Males achieved 70.9% optimal treatment, while 17.1% were suboptimal. Females achieved 81.6% optimal treatment rates with 17.7% classified as suboptimal. The missed data is very low, with only one case (0.6%) among females and none among males. The proportion of suboptimal treatment is slightly higher in females (17.7%) compared to males (17.1%), but the difference is minimal. The p-value (0.909) suggests no statistically significant difference between males and females in terms of treatment optimization.

Since gender does not significantly influence treatment optimization (p = 0.909), other factors such as adherence, access to healthcare, or biological differences may be more relevant in explaining variations in treatment outcomes. Further analysis should explore age group differences, orphan status, or other socioeconomic factors that might contribute to suboptimal treatment (Table 4).

Table 4: Treatment Optimization Rates

Characteristic variable	Sub optimal N=35 n (%)	Optimal N=163 n (%)	Missed N=1 n (%)	P value
Gender				
Male	7(17.1)	34(70.9)	0(0.0)	0.909
Female	28(17.7)	129(81.6)	1(0.6)	

Shows findings are statistically not significant (p>0.05)

4.3.3 Viral Load Response Breakdown by Age Groups

The 5–9 years age group shows a very high rate of suppression (94.1%) with 16 out of 17 participants achieving viral suppression. No participants in this age range had unsuppressed viral load (0.0%). Only one (5.9%) participant's data is missing, reflecting good follow-up in this group.

In the 10-14 years age group, a majority achieved viral suppression of 83.9%, but slightly lower than the 5–9 group. A small portion (6.5%) did not achieve suppression, which may require further investigation into adherence or treatment efficacy.

In the 15–19 years age group, there was a decline in suppression rates (70.2%) compared to younger age groups, potentially pointing to challenges such as adherence, transition and behavioral factors, or treatment resistance. A notable portion (14.6%) had unsuppressed viral load, the highest among all age groups. This raises concerns about potential barriers specific to older adolescents. Missing data is relatively high here 15.2%, possibly reflecting difficulties in follow-up or engagement with this age group.

Overall, viral suppression rates decrease with increasing age, from 94.1% in the 5–9 group to 70.2% in the 15–19 group. This trend may indicate age-related factors affecting treatment adherence or intervention outcomes. The older adolescent group (15–19 years) has the highest unsuppressed viral load and missed data rates, which could signify challenges like engagement, social factors, or healthcare access. The P value of 0.155 suggests that the differences in viral load response across age groups are not statistically significant, but the trends observed may still warrant further exploration. (Table 5).

Table 5: Viral Load Response Breakdown by Age Groups

Characteristic variable	Suppressed N=148 n (%)	Unsuppressed N=24 n (%)	Missed N=27 n (%)	P value
Age group				
5 – 9	16(94.1)	0(0.0)	1(5.9)	0.155
10 – 14	26(83.9)	2(6.5)	3(9.7)	
15 – 19	106(70.2)	22(14.6)	23(15.2)	

Shows no statistical significance because (p>0.05)

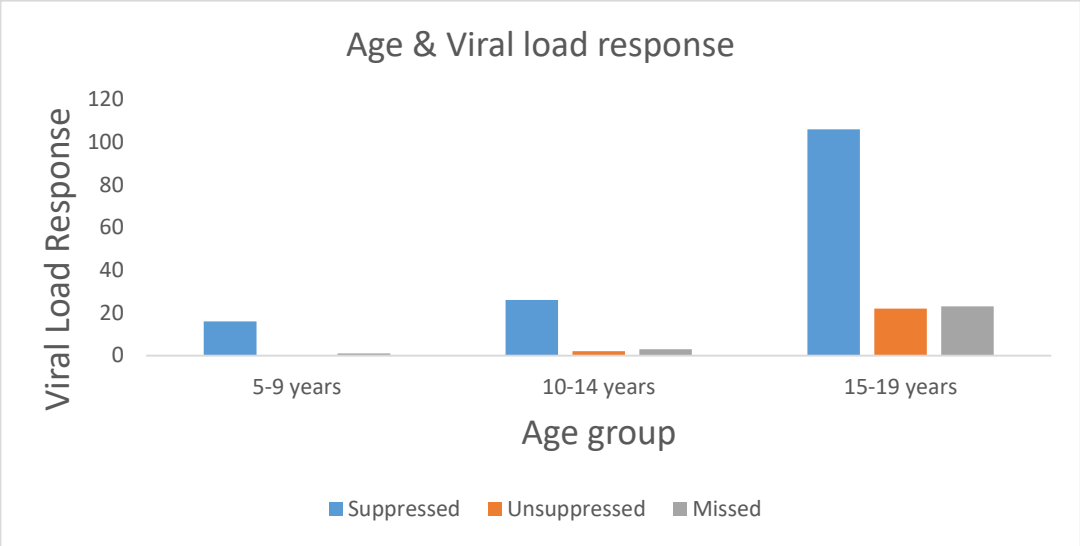

Figure 3: Viral load response by age group

4.3.4 Treatment Optimization by Age

100% of children in the 5–9 and 10–14 age groups had optimal treatment, meaning there were no cases of suboptimal treatment in these age groups. Among adolescents aged 15–19 years, 76.2% had optimal treatment, but 23.2% were classified as suboptimal. One case (0.7%) was missing in the 15–19 age group. The Statistical Significance is (P = 0.001), p-value (0.001) indicates a statistically significant difference in treatment optimization across age groups. This suggests that age significantly affects treatment optimization, with older adolescents (15–19 years) being more likely to experience suboptimal treatment compared to younger age groups.

Younger children (5–14 years) had high treatment optimization (100%), indicating strong adherence and effective ART management in these age groups. Older adolescents (15–19 years) had the highest rate of suboptimal treatment (23.2%), which could be due to adherence challenges, psychosocial factors, transition to adult care, or other barriers faced by teenagers.

Given the significant p-value, interventions should focus on improving ART adherence and support systems for adolescents aged 15–19 years, as they are the most vulnerable to suboptimal treatment (Table 6).

Table 6: Treatment optimization by age

Characteristic variable	**Optimal N=163 n (%)**	**Suboptimal N=35 n (%)**	**Missed N=1 n (%)**	**P value**
Age group				
5 – 9	17(100.0)	0(0.0)	0(0.0)	0.001*
10 – 14	31(100.0)	0(0.0)	0(0.0)	
15 – 19	115(76.2)	35(23.2)	1(0.7)	

*****Shows findings are statistically significant (p< 0.05)

4.4 Sociodemographic and clinical factors associated with varying levels of viral load suppression

4.4.1 Viral Suppression by Disclosure Status

Among those whose HIV status was disclosed, 72.3% achieved viral suppression, while 12.1% were unsuppressed, and 15.6% had missing viral load data. Among participants whose status was not disclosed, 82.4% had suppressed viral load, and 17.6% were unsuppressed, with no missing data. All participants with "Not Indicated" disclosure status (100%) had suppressed viral load, suggesting full adherence or a small sample size effect. Statistical Significance (P = 0.157). The p-value (0.157) is greater than 0.05, meaning there is no statistically significant difference in viral

suppression between disclosed and non-disclosed groups. This suggests that disclosure status alone does not significantly impact viral suppression in this study.

While viral suppression appears slightly higher in the "Not Disclosed" group (82.4%) compared to the "Disclosed" group (72.3%), this difference is not statistically significant.

The higher percentage of missing data (15.6%) in the disclosed group may have affected the results and should be further investigated. Since disclosure is often linked to treatment adherence and psychological well-being, further analysis is needed to determine whether other factors such as age, gender, or adherence behaviours interact with disclosure status to influence viral load outcomes (Table 7).

Table 7: Viral Suppression by Disclosure Status

Characteristic variable	**Suppressed N=148 n (%)**	**Unsuppressed N=24 n (%)**	**Missed N=27 n (%)**	**P value**
Disclosure status				
Disclosed	125(72.3)	21(12.1)	27(15.6)	0.157
Not Disclosed	14(82.4)	3(17.6)	0(0.0)	
Not indicated	9(100)	0(0.0)	0(0.0)	

Shows findings are statistically not significant (p>0.05)

4.4.2 Treatment Optimization by Disclosure Status

Among participants with disclosed HIV status, 80.2% achieved optimal treatment, while 19.8% had suboptimal treatment. In the "Not Disclosed" group, 94.1% achieved optimal treatment, and only 5.9% were suboptimal, suggesting a slightly better treatment outcome. All participants with "Not Indicated" disclosure status (100%) had optimal treatment, which may be due to a small sample size or specific characteristics of this group.

Statistical Significance (P = 0.130). The p-value (0.130) is greater than 0.05, indicating that there is no statistically significant association between disclosure status and

treatment optimization. This suggests that disclosure status alone does not strongly influence whether treatment is optimal or suboptimal.

While treatment optimization is slightly higher among those whose HIV status was not disclosed (94.1%) compared to those whose status was disclosed (80.2%), this difference is not statistically significant. The 19.8% suboptimal treatment rate in the disclosed group may indicate challenges such as psychological distress, stigma, or adherence difficulties after disclosure. Further analysis is needed to explore whether other factors such age, gender, adherence support, or social factors interact with disclosure status to impact treatment outcomes (Table 8).

Table 8: Treatment Optimization by Disclosure Status

Characteristic Variable	**Suboptimal N=35 n (%)**	**Optimal N=163 n (%)**	**P value**
Disclosure status			
Disclosed	34(19.8)	138(80.2)	0.130
Not Disclosed	1(5.9)	6(94.1)	
Not indicated	0(0.0)	(100.0)	

Shows findings are statistically not significant (p>0.05)

4.4.3 Viral Suppression by Caregiver Status

The highest viral suppression rates (100%) were seen among those cared for by a cousin or other (Director of Orphanage), likely a very small sample size. Children cared for by parents had a suppression rate of 77.0%, with 10.8% unsuppressed and 12.2% missing data. The lowest suppression rate (60.9%) was among those cared for by siblings, with 13.0% unsuppressed and the highest percentage of missing data (26.1%). Participants whose caregiver was spouse/partner had the highest unsuppressed rate (23.1%), indicating possible challenges in treatment adherence in this group. These participants were mainly Antenatal and Postnatal mothers.

Statistical significance (P = 0.596). The p-value (0.596) is greater than 0.05, meaning there is no statistically significant association between caregiver status and viral suppression. This suggests that caregiver status alone does not significantly impact viral load outcomes in this sample. Although caregiver status does not show a statistically significant effect on viral suppression, some trends are notable, children cared for by siblings had the lowest suppression rate (60.9%) and the highest missing data (26.1%), suggesting they may face adherence challenges. Those cared for by a spouse/partner had the highest unsuppressed rate (23.1%), which may indicate differences in adherence support.

Further research is needed to explore whether factors like age, adherence counselling, or social support systems contribute to differences in viral suppression among different caregiver groups (Table 9).

Table 9: Viral Suppression by Caregiver Status

Characteristic variable	**Suppressed N=148 n (%)**	**Unsuppressed N=24 n (%)**	**Missed N=27 n (%)**	**P value**
Care giver status				
Parent (s)	57(77.0)	8(10.8)	9(12.2)	0.596
Sibling	14(60.9)	3(13.0)	6(26.1)	
Aunt/Uncle	18(81.8)	1(4.5)	3(13.6)	
Spouse/partner	26(66.7)	9(23.1)	4(10.3)	
Grandparent	19(76.0)	3(12.0)	3(12.0)	
Cousin	1(100.0)	0(0.0)	0(0.0)	
Other	2(100.0)	0(0.0)	0(0.0)	
Not indicated	11(84.7)	0(0.0)	2(15.3)	

Shows findings are statistically not significant (p>0.05)

4.4.4 Treatment Optimization by Caregiver Status

The highest optimal treatment rates (100%) were noted among participants under the care of cousin, other (Director of Orphanage) and “Not Indicated” group with no cases of suboptimal treatment. Children cared for by parents had the lowest optimal treatment rate of 78.4%, with 21.6% categorised as suboptimal. Participants cared for

by a spouse/partner had the second lowest optimal treatment (79.0%) and suboptimal treatment of 21.0% indicating possible challenges in treatment adherence in this group. Statistical significance (P = 0.212). The p-value (0.212) is greater than 0.05, meaning there is no statistically significant association between caregiver status and treatment optimization. This suggests that caregiver status alone does not significantly impact treatment optimization in this sample.

Table 10: Treatment Optimization by Caregiver Status

Characteristic variable	**Optimal N=163 n (%)**	**Suboptimal N=35 n (%)**	**P value**
Care giver status			
Parent (s)	58(78.4)	16(21.6)	0.212
Sibling	20(87.0)	3(13.0)	
Aunt/Uncle	19(86.4)	3(13.6)	
Spouse/partner	30(79.0)	8(21.0)	
Grandparent	21(84.0)	4(16.0)	
Cousin	0(0.0)	1(100.0)	
Other	2(100.0)	0(0.0)	
Not indicated	13(100.0)	0(0.0)	

Shows findings are statistically not significant (p>0.05)

4.4.5 Viral Suppression by Orphan Status

Double orphans had the highest viral suppression rate (100%), with no unsuppressed or missed data. However, this group had a small sample size. Single orphans had a suppression rate of 85.7%, with 17.1% unsuppressed and no missing data. Participants classified as "Not Applicable"(above 15 years of age) had the lowest suppression rate (71.3%), with 13.4% unsuppressed and 15.3% missing data. The "Not Indicated" group had 83.3% suppression, 6.7% unsuppressed, and 10.0% missing data.

Statistical Significance (P = 0.555). The p-value (0.555) is greater than 0.05, meaning there is no statistically significant association between orphan status and viral suppression. This suggests that orphan status alone does not significantly impact viral load outcomes in this study sample. Although there is no statistically significant effect,

some trends are notable, double orphans had the best viral suppression rates (100%), possibly due to institutional care or strong adherence support from guardians. The “Not Applicable” group (15-19) had the lowest suppression rate (71.3%), which may indicate differences in adherence support, family structure, or socioeconomic conditions. Single orphans had slightly better suppression rates (85.7%) than non-orphans (71.3%), but had a higher unsuppressed rate (17.1%). Missing data was highest in the group whose status was not relevant in the study context (15.3%), which could reflect challenges adherence monitoring in this subgroup. Further investigation is needed to determine whether other factors such as caregiver support, adherence counselling, socioeconomic status play a role in treatment outcomes (Table 11).

Table 11: Viral Suppression by Orphan Status

Characteristic variable	**Suppressed N=148 n (%)**	**Unsuppressed N=24 n (%)**	**Missed N=27 n (%)**	**P value**
Orphan status				
Not applicable	112(71.3)	21(13.4)	24(15.3)	0.555
Single	6(85.7)	1(17.1)	0(0.0)	
Double	5(100.0)	0(0.0)	0(0.0)	
Not indicated	25(83.3)	2(6.7)	3(10.0)	

Shows no statistical significance (p> 0.05)

4.4.6 Treatment Optimization by Orphan Status

Single and double orphans had a 100% optimal treatment rate, with no cases of suboptimal treatment. Participants in the "Not Applicable" category (15-19 years) had the lowest optimal treatment rate (78.2%), with 21.8% classified as suboptimal. The "Not Indicated" group had a high optimal treatment rate (96.7%), with only 3.3% suboptimal.

Statistical Significance (P = 0.035). The p-value (0.035) is less than 0.05, indicating a statistically significant association between orphan status and treatment optimization.

This suggests that orphan status influences treatment outcomes, with orphans having better treatment optimization compared to non-orphans. Orphans had the best treatment optimization rates (100%), possibly due to structured care, external support systems such as OVC NGOs, orphanages, or stricter adherence monitoring. The 15-19 years (Not Applicable) had the lowest treatment optimization (78.2%), with a notable 21.8% suboptimal rate, suggesting possible adherence challenges, household instability, or lack of structured treatment support. The significant association (p = 0.035) highlights the importance of exploring how caregiver support, socioeconomic factors, and healthcare access contribute to treatment success (Table 12).

Table 12: Treatment Optimization by Orphan Status

Characteristic variable	**Optimal N=163 n (%)**	**Suboptimal N=35 n (%)**	**P value**
Orphan status			
Not applicable	122(78.2)	34(21.8)	0.035
Single	7(100.0)	0(0.0)	
Double	5(100.0)	0(0.0)	
Not indicated	29(96.7)	1(3.3)	

*****Shows statistical significance (p< 0.05)

4.4.7 Viral Suppression by Treatment Regimen

The ABC/3TC/EFV, ABC/3TC/LPV/r, and AZT/3TC/DTG regimens had 100% suppression, with no unsuppressed cases. TDF/3TC/DTG was the most common regimen, with 72.3% suppressed, 13.3% unsuppressed, and 14.6% missing data. ABC/3TC/DTG had a high suppression rate (84.2%), but a small number of unsuppressed (5.3%) and missing data (10.5%). Statistical Significance (P = 0.950): The p-value (0.950) is greater than 0.05 indicating that there is no statistically significant difference in viral suppression across different treatment regimens. Based

on this data, this suggests that the choice of regimen did not significantly affect the suppression rates.

Regimens with 100% suppression rates (ABC/3TC/EFV, ABC/3TC/LPV/r, AZT/3TC/DTG, TDF/3TC/EFV) suggest that these combinations may be highly effective in achieving viral suppression when adhered to properly. TDF/3TC/DTG, the predominately used regimen, shows a lower suppression rate (72.3%), which may suggest adherence challenges or other factors such side effects, co-morbidities, or resistance. The missing data particularly for the TDF/3TC/DTG regimen may indicate difficulties in tracking or monitoring viral load outcomes for certain patients, possibly due to non-adherence or inconsistent follow up (Table 13).

Table 13: Viral Suppression by Treatment Regimen

Characteristic variable	**Suppressed N=148 n (%)**	**Unsuppressed N=24 n (%)**	**Missed N=27 n (%)**	**P value**
Treatment regimen				
ABC/3TC/DTG	16(84.2)	1(5.3)	2(10.5)	0.950
ABC/3TC/EFV	2(100.0)	0(0.0)	0(0.0)	
ABC/3TC/LPV/r	2(100.0)	0(0.0)	0(0.0)	
AZT/3TC/DTG	2(100.0)	0(0.0)	0(0.0)	
TDF/3TC/DTG	125(72.3)	23(13.3)	25(14.6)	
TDF/3TC/EFV	1(100.0)	0(0.0)	0(0.0)	

Shows findings are statistically not significant (p>0.05)

4.5 Adherence to ART

4.5.1 Viral Suppression by Adherence Level

Suboptimal adherence had the lowest suppression rate (31.4%), with 42.9% unsuppressed and 25.7% missing data. Optimal adherence showed 84.0% suppression, with 5.5% unsuppressed and 10.4% missing data. Statistical Significance ($P < 0.0001$). The p-value (<0.0001) is highly significant, indicating a strong association between adherence level and viral suppression. This suggests that optimal adherence is strongly correlated with better viral load suppression, while suboptimal adherence is associated with poorer outcomes.

Patients with optimal adherence achieved significantly better viral suppression rates (84%) compared to those with suboptimal adherence (31.4%). This highlights the critical role of adherence in achieving viral suppression. Suboptimal adherence was strongly linked to unsuppressed viral load (42.9%) and missing data (25.7%), indicating that poor adherence not only affects suppression but also leads to incomplete data reporting or monitoring.

The strong statistical significance of the p-value suggests that improving adherence levels could lead to significant improvements in treatment outcomes, emphasizing the need for adherence interventions in this population. Given the strong association with viral suppression, implementing or enhancing adherence support programs such as counselling, reminders, pillboxes, community support could greatly improve outcomes for patients with suboptimal adherence (Table 14).

Table 14:Adherence levels and viral load response

	Suppressed N=148 n (%)	Unsuppressed N=24 n (%)	Missed N=26 n (%)	P value
Adherence levels				
Suboptimal	11(31.4)	15(42.9)	9(25.7)	0.001
Optimal	137(84.0)	9(5.5)	17(10.4)	

*Shows statistical significance (p< 0.05)

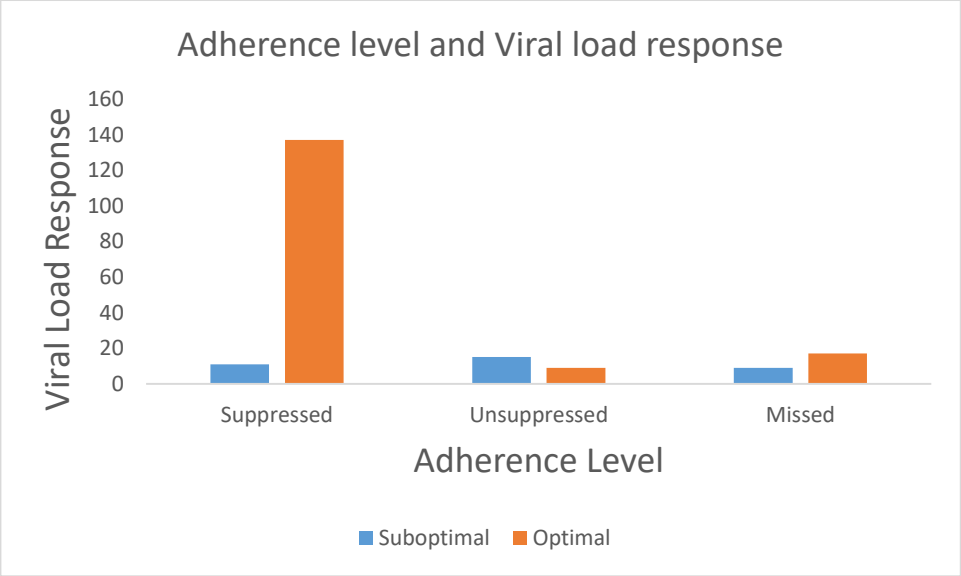

Figure 4: Viral load response and adherence levels

4.6 Summary

In this secondary analysis of data, 199 participants with a median age of 18 years were recruited. 86.5% of participants underwent viral load testing at six -nine months post ART initiation. 74.4% were virally suppressed, 12.1% were unsuppressed and 13.6% were missed opportunities. VL suppression declined with increasing age group, 5-9 years (94.1%), 10-14 (83.9%) age group and 15-19 (70.2%). Females had higher suppression and treatment optimization rate compared to males. The participants under the care of parents achieved suppression rate of 77.0% and treatment optimization

78.4%. The participants with spouse/partner as their caregiver had the highest unsuppressed rate at 23.1%. Single orphans had suppression rate of 87.5% and double orphans achieved 100% VL suppression. Suboptimal adherence to ART was strongly associated with unsuppressed viral load. In addition, there was statistical association between orphan status and treatment optimization as well as age and treatment optimization.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the study findings and makes comparison with existing literature on viral load response in CLHIV on ART. The chapter also provides critical recommendations to the BCC DHE and the nine BCC supported facilities.

5.2 Discussion

This study analysed data for 199 participants from nine BCC clinics in Bulawayo aged 5-19 years who were initiated on ART between January 2021-June 2023 and received ART for six months and were eligible for baseline viral load assessment at six to nine months post ART initiation.

5.2.1 Viral Load Response

In this study, the viral load suppression rate was 74.4% and 12.1% were virally unsuppressed. The suppression rate observed in this study is lower than the 95% global targets for viral load suppression (UNAIDS, 2021) but comparable to the one noted by Kassa et al. (2021), where viral suppression rate among children on ART across various countries was 76%. Contrary to the findings reported by Mothibi et al. (2020), CHIV in South Africa achieved a better viral load suppression (80%) higher than the current study findings.

This study also revealed a significant finding of missed opportunities (13.6%) for baseline viral load monitoring at 6-9 months post ART initiation almost similar to findings by Moyo et al. (2021) in a study conducted at Mpilo hospital to assess the extent to which routine VL monitoring is implemented at six months whereby 17% of CLHIV were missed for baseline viral load. The missed opportunities do not only affect the ability to monitor treatment efficacy but also had an impact on measuring

the “accurate” viral load response. In addition, this finding highlights the potential gaps in the healthcare system, including barriers to access and follow-up care.

5.2.2 Viral Suppression Rates

In this study,75.9% of females achieved viral suppression, while 10.8% remained unsuppressed. In contrast, 68.3% of males achieved viral suppression, with 17.1% remaining unsuppressed. The similar trend was noted in a study by Mothibi et al. (2020) noted that female adolescents had a viral suppression rate of 75%, while male adolescents had a lower suppression rate of 65%, contrary to Tayong et al. (2025) in the North West Region of Cameroon indicated that males had a higher viral load suppression rate than females, with 94% of males achieving suppression compared to 91% of females.

While 14.6% of males were missed for VL collection compared to 13.3% of their female counterparts, the difference is only 1.3% thus has no significant impact on viral load response outcomes. The low viral load suppression observed may also be linked to association of gender and adherence levels, males reported optimal adherence levels of 70.9% compared to females at 81.6%. The findings show gender related disparities suggesting that female CLHIV in this cohort have a higher likelihood of achieving viral suppression compared to their male counterparts. However, on bivariate analysis, shows findings were statistically not significant.

Since the study showed gender related differences in VL response, there is need for gender-sensitive approaches to HIV treatment and care, particularly for male adolescents with additional challenges in achieving viral suppression.

5.2.3 Treatment Optimization Rates

The study shows that males had optimal adherence of 70.9% and sub optimal adherence of 17.1% with females achieving an optimal adherence rate of 81.6% and

17.1% sub optimal treatment optimization rates of 17.1% comparable to findings by Karam et al. (2021) that 75% of females and 72% of males adhered optimally to ART. Nonetheless, Karanja et al. (2020) found that 70% of males and 68% of females reporting optimal adherence showing disparities in females in South Africa.

Relating these findings of gender and adherence, the low viral suppression achieved by males in this study suggest that males are having challenges with adherence. While findings suggest association between gender and adherence, bivariate analysis shows findings are statistically not significant.

5.2.4 Viral load Response and Breakdown by Age groups

The findings observed that viral load suppression rates vary considerably across different age groups with younger children showing higher viral load suppression, 94.1% for 5-9 years age group followed by 83.9% for the 10-14 years with least suppression rate (70.2%) for the 15-19 years age group. The findings are almost a similar to 90% suppression rate for 5-9 years age group and 60-70% suppression rate for the 15-19 years age group reported by (Kassa et al. ,2021). Similarly, the low viral load suppression in older adolescents was noted by Karam et al. (2020) attributed to increased barriers to adherence, developmental changes, social pressures and greater likelihood of engaging in risky behaviours.

The 15.2% study participants missed for VL collection in the 15-19 age group compared to 9.7% (10-14) and 5.9% (5-9%) creates a potential under estimation of viral load response in this age group, also noted by Moyo et al. (2021) at Mpilo hospital.

5.2.5 Treatment Optimization by Age groups

In this study, the optimal adherence level for 5-14 years was 100% and 76.2% for 15-19 years age group. The reported suboptimal levels for 15-19 years age group was

23.3%, comparable to findings by Chawira et al. (2021) indicating that adherence rates among adolescents aged 15-19 years were lower (68%) compared to younger children. The measurement of adherence is this study relied mostly on self -reported adherence levels recorded in the patient OI/ART booklets which are prone to bias. The decline in adherence among older adolescents is similar to findings by Karam et al. (2020) who further associated the findings to various factors such as developmental transitioning, social pressures and stigma.

Bivariate analysis showed that association between the age group and adherence levels was statistically significant. In addition, there is a moderate association between age group and adherence levels (Cramer's V value of 0.262).

5.2.6 Viral Suppression by Disclosure Status

The findings showed that viral load suppression for participants who disclosed their HIV status was 72.3% and 12.1% were virally unsuppressed. In addition, those who did not disclose their status achieved viral load suppression rate of 82.4% and 17.6% were virally unsuppressed. Almost similar findings were reported in a Uganda by Nabukeera et al. (2021), they found that viral load suppression rate for adolescents on ART who disclosed their status was 78% while those who did not disclose had a suppression rate of only 65% contradicting with study findings of viral load suppression and non-disclosure status.

The non-availability of adolescent transition forms in the Patient OI/ART booklets specifically designed to evaluate disclosure and type of disclosure (partial, complete, or none of younger children may have affected the assessment of their disclosure status. This is most likely contributing to the findings observed in this study that disclosure of HIV status is not significantly associated with viral load response.

5.2.7 Treatment Optimization by Disclosure Status

The results show that 80.2% of participants who disclosed their HIV status reported optimal adherence levels and 19.8% had suboptimal adherence. Among those who had not disclosed their HIV status, 94.1% reported optimal viral suppression, with only 5.9% classified as suboptimal. The results align with several studies such as systematic review by Fatti et al. (2017) indicated that among children and adolescents who disclosed their status, 75% had optimal treatment optimization, leading to improved treatment adherence.

However, not all literature supports the positive correlation between disclosure and treatment outcomes. Rotheram-Borus et al. (2015) found that early disclosure of HIV status could lead to stigma and discrimination, potentially resulting in poor adherence to ART. Their findings indicated that only 50% of adolescents who disclosed their HIV status had optimal adherence, affecting viral load response.

While this study indicates a complex relationship between disclosure status and treatment outcomes, the bivariate analysis shows findings are statistically not significant.

5.2.8 Viral Suppression by Caregiver Status

This study found that CLHIV under the care of parents achieved a viral load suppression rate of 77% aligning with a study by Kinyanjui et al. (2018), they found that adolescents who reported strong family support had viral suppression rates of approximately 75%, similar to the 77% observed in this study for CLHIV with parents as their next of kin. CLHIV under the care of extended family members (aunt, uncle) showed a higher suppression rate of 81.8% contradicting the findings by Mavhu et al. (2013) that reported a viral load suppression rate of 50% among the adolescents living with extended family.

The findings from this study, particularly the lower suppression rates among siblings (60.9%) and spouses (66.7%), may reflect the complexities of family dynamics, where sibling relationships and spousal support may not always be as strong as parental or extended family support. The unsuppressed rates of 10.8% for participants under the care of parents and 13.0% for spouses suggest that even within family relationships, there may be challenges related to stigma or communication that affect optimal treatment adherence.

Whilst the results indicate the strong association between next of kin/care giver relationship and viral load response, bivariate analysis shows no statistical association between the two variables.

5.2.9 Viral Suppression by Orphan status

In this study, double orphans had 100% viral suppression and single orphans had 85.7%. In addition, where orphan status was not documented, 83.3%, were virally suppressed, 6.7% were virally unsuppressed and 10% were missed for viral load collection. The findings of this study are consistent with several existing studies that emphasize the positive impact of stable family structures on health outcomes for CLHIV. Mothiba et al. (2017) observed that if placed in supportive environments, orphans achieved optimal health outcomes, with viral suppression rates of 95%. On the contrary, Cluver et al. (2015) and Nakanjako et al. (2018) showed lower viral suppression of 60% and 70% amongst orphans suggesting that this population has increased psychosocial stressors and lack of support affecting their health outcomes.

In addition, the study revealed 83.3% viral load suppression rate among participants with missing documentation on orphan status raises concerns about the implications of incomplete data that can result in underestimations of treatment efficacy, a similar

finding by Kagee et al. (2019) that missing documentation may hide challenges faced by the vulnerable populations resulting in poorer health outcomes.

Above all, bivariate analysis shows statistical significance with a moderate association between orphan status and adherence as evidenced by the Cramer's value of 0. 209.The results also highlight the challenges associated with missing documentation, which can impact the assessment of treatment efficacy.

5.2.10 Treatment Optimization by Orphan Status

The study found that optimal adherence for either single or double orphaned was 100% and 3.3% of participants with no documented orphan status reported suboptimal adherence levels. Almost similar findings were reported by Mavhu et al. (2015) noted that 85% of orphans in supportive households achieved optimal adherence, consistent with the 100% adherence rate observed among single and double orphans in this study. The 3.3% suboptimal adherence rate among participants with no documented orphan status raises concerns about the implications of incomplete data and this is consistent with findings by Nakanjako et al. (2018), they observed that missing data may hide support system barriers faced by orphans and vulnerable children resulting in sub optimal adherence with resultant poor health outcomes.

These findings suggest a correlation between orphan status and adherence to ART, highlighting the importance of family support and supportive caregivers in enhancing treatment adherence. Also, bivariate analysis show that findings are statically significant suggesting that orphan status has a meaningful impact on adherence levels among children living with HIV on ART.

5.2.11 Viral Suppression by Treatment Regimen

In this study, ART regimen featured were TDF/3TC/DTG, ABC/3TC/DTG, ABC/3TC/EFV.

Among CLHIV on DTG based regimen, 96.6% achieved viral load suppression and this occurrence was almost similar to the 98% reported by Kallander et al. (2020). TDF/3TC/DTG was the predominant regimen with a frequency of 86.9%, followed by ABC/3TC/DTG at 9.5%. AZT/3TC/DTG, ABC/3TC/LPVr and ABC/3TC/EFV each had a frequency of 1% and TDF/3TC/EFV had a frequency of 0.5%. Among CLHIV on TDF/3TC/DTG, 86.7% achieved viral load suppression and this occurrence was almost similar to 85% viral load suppression rate reported by Kityo et al. (2019). The 13.3% frequency in unsuppressed viral load resonates with Cluver et al. (2016) who noted that sub optimal viral suppression for CLHIV on DTG based are mainly attributed to adherence issues.

In addition, the occurrence of viral load response for TDF/3TC/DTG regimen is also influenced by the frequency (14.5%) of CLHIV missed for viral load collection at 6-9 months post ART initiation. The missed appointments and lack of follow-up can significantly impact the ability to correctly monitor treatment efficacy.

Viral load suppression for CLHIV on ABC/3TC/DTG was 94.7% in this study, almost similar to Kagee et al. (2020) where 92% of CLHIV achieved viral load suppression. These findings reinforce the notion that both TDF/3TC/DTG and ABC/3TC/DTG are effective treatment options for CLHIV, contributing to improved health outcomes. In addition, CLHIV on EFV and LPV/r-based regimen attained 100% suppression rate contrary to Mavhu et al. (2018) in where children on alternative regimens, such as EFV and NVP-based therapies, had lower suppression rates, with only 70% achieving viral load suppression.

5.2.12 Viral Suppression by Adherence Levels

This study shows that the frequency of viral load suppression in CLHIV with optimal adherence was 84% and 31.4% had suboptimal adherence levels. The frequency of

viral load suppression for CLHIV with optimal adherence support the notion that high adherence levels is consistently associated with improved viral load suppression highlighted by Kacanek et al. (2020) where they point out that CLHIV with optimal adherence achieved viral load suppression rates above 90%. Similarly, the importance of maintaining adherence levels above 95% to improve load suppression is noted in a quality improvement initiative in Nigeria that included enhanced adherence counseling reported that 77.2% of children achieved viral suppression after six months (Okafor et al., 2023).

However, there are also contrasting perspectives such as by Koay et al. (2021), they argue that despite high adherence rates in CLHIV in Cameroon, viral load suppression rates were not optimal, suggesting that other factors, such as drug resistance and regimen effectiveness, may also play a role in viral load suppression. This study further showed that the frequency of viral load suppression for CLHIV reporting sub optimal adherence was 31.4 % aligning with 50% viral load suppression observed at Mpilo for CLHIV with poor adherence (Moyo et al., 2021).

In addition, the study also revealed that a notable proportion (26.7%) with suboptimal adherence were missed for viral load consistent with findings in Malawi where adolescents who missed regular follow-up appointments had poor monitoring of viral load and treatment outcomes (Munyayi et al., 2024). The implications of missed assessments are profound, as they can hinder the ability to provide timely interventions and support for those struggling with adherence.

The correlation between adherence levels and viral load outcomes is evident in this study. The bivariate analysis indicate that findings are statistically significant with as strong association between adherence levels and viral load suppression (Cramer's value is 0.497).

5.3 Conclusions

Secondary analysis of viral load response and associated factors data from nine BCC supported facilities for the period 1 January 2021 to June 2023 adherence to ART was strongly associated with high rates of viral suppression. Only 86.5% CLHIV eligible for viral load collection during the study had viral load samples collected with a viral load suppression of 74.4%. Factors such as age group and adherence, orphan status and adherence had moderate association. Other factors such as disclosure, ART treatment regimen and caregiver relation were less likely to influence viral load response when compared to adherence to ART treatment

The patient OI/ART booklets and Electronic Health Record (EHR) from where the secondary data was extracted had a high degree of completeness on age and gender, but very low on critical variables like adherence, orphan status, disclosure and caregiver status. They do not only have significant implications for individual health outcomes but also public health strategies. There is urgent need to strengthen health systems, though policy development, capacity building of health care workers on advanced HIV care management, improving health care structures, and ongoing research is essential to close this gap and ensure that children receive the comprehensive care they need.

5.4 Implications

While adherence level is generally associated with high viral load suppression, there are interplay of factors that influence viral load response. These range from socio-cultural, economic, clinical and health. For this reason, it is important that health care workers, individuals and community continue to employ multifaceted approach in management of CLHIV to improve individual health outcomes and preventing transmission

5.5 Suggestions for further research

This study was carried out in only nine BCC supported facilities, hence there is need to conduct a provincial-wide study covering the 25 public health facilities offering ART services to improve the generalisability of the findings in Bulawayo. In addition, future studies to include 0-5 years age group, clinical characteristics and immune response in this age group maybe different and this is an area that needs research. Furthermore, a study which utilizes mixed method, qualitative research would explore the lived experiences of adolescents on ART, which could inform more effective interventions.

5.6 Recommendations

Area	Recommendation	Time frame	Responsible person
Missed viral load at 6-9 months post ART initiation	• Capacitate health workers through on the job training and mentorship on HIV management including viral load monitoring algorithm. • Procure HIV guidelines and Standard Operations such as Operational Services Delivery Manuals (OSDM) and Job Aides for reference by Health Care Workers • Scale up utilization of tracking system for patient appointments and due dates for viral load collection, using electronic health records or Cohort calendars. • Conduct health dialogues with Recipients of Care/care givers to improve treatment literacy on HIV and viral load monitoring. • Implement reminder systems (SMS/phone calls) for Recipient of Care/care givers to ensure timely viral load testing. • Integrate viral load testing into regular clinical visits for other health services. • Scale up Adolescent Differentiated Service Delivery	• From 30 April 2025	• BCC Health Executive • HIV Focal Person • HIV mentors • Charge nurses

	models scheduling the clinic during school holiday. • Scale up collaboration with OVC partners for community tracking • Data analysis of Viral load monitoring, weekly, monthly, quarterly and annual.		
Low viral load suppression <95%	• Investigate the barriers that may be contributing to lower suppression rates and higher unsuppressed rates in the 15–19 age. • Scale up targeted adherence counseling and support groups for children and their caregivers. • Scale up DSD models for paediatrics and adolescents • Utilize peer support models were adolescents' mentor younger children on adherence. • Regular follow-up appointments and monitoring for potential treatment failure. • Scale up collaboration with OVC partners to provide psychosocial support, economic strengthening and positive parenting.	• From 30 April 2025	• BCC Health Executive • HIV Focal Person • Charge nurses
Missing data in patient OI/ART booklets and EHR	• Standardize patient ART and OI booklet documentation processes to ensure completeness. • Refresher trainings for healthcare workers on accurate documentation practices and the importance of maintaining patient records. • Conduct regular audits of documentation to identify and address gaps promptly. • Support scale of utilization of E-first Electronic Health Records system to reduce gaps in documentation.	• From 30 April 2025	• BCC Health Executive • HIV Focal Person • HIV mentors • Charge nurses

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APPENDICES

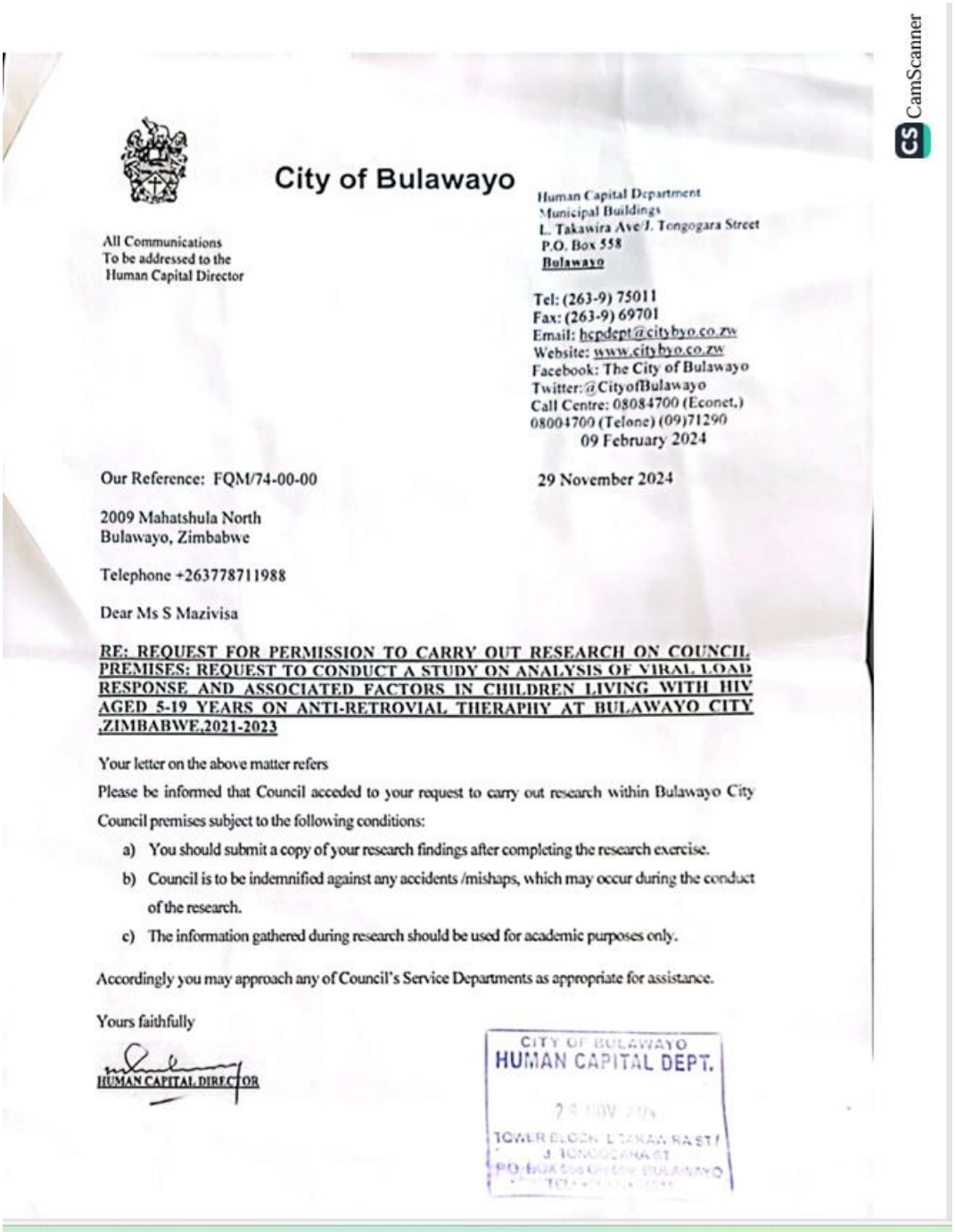
Appendix 1: Description of Variables

Variable Description	Variable Name
Form completion date (dd/mm/yyyy)	Completion Date
Unique patient ID	Unique_Patient_ID
Date registered for ART at the facility (dd/mm/yyyy)	ART_Registration_Date
Date of birth (dd/mm/yyyy) or age (as recorded)	Date_of_Birth_or_Age
Age	Age Group (5-9 / 10-14 / 15-19)
Sex	Gender (Female / Male / Other / Do Not Know)
Orphan	Orphan Status (Yes / No / Unknown)
If yes, indicate:	Orphan Type (Double / Single)
Location of residence (specify name)	Residence Location
Disclosure Status (has the child been informed about their HIV status?)	Disclosure Status (Yes / No)
Date of HIV diagnosis (dd/mm/yyyy)	HIV_Diagnosis_Date
Date of ART initiated (dd/mm/yyyy)	ART_Initiation_Date
Current ART Regimen (Drug name & dosage)	Current_ART_Regimen
Date of last viral load was done (dd/mm/yyyy)	Last_Viral_Load_Date
Date viral load results were received (dd/mm/yyyy)	Viral_Load_Results_Date
Viral load results (copies/mL)	Viral_Load_Results
Viral suppression	Viral Suppression (Yes / No)
Reported adherence level (as recorded)	Adherence Level (Excellent / Good / Fair / Poor)
Any history of missed appointments (as recorded)	Missed Appointments (Yes / No)
If yes, specify time frame from time of ART initiation	Missed_Appointment_Time_Frame (0-3 / 4-6 / 7-9 / 10-12 months)
Reason for missed appointment (as recorded)	Reason_for_Missed_Appointment
Relationship of caregiver/next of kin (as recorded)	Caregiver Relationship
Specify the relationship	Caregiver_Relationship_Specify

Appendix 2: Data Collection Tool

Age	Sex	Orphan Status	Next of kin Relationship	Place of residence	Disclosure status	Date of HIV diagnosis	Date of ART initiation	Treatment Regimen	History of missed appointment (s) and duration	Time frame of missed appointment from time of ART initiation	Reason (s) of missed appointment	Reported adherence level	Date of last viral load	Viral load results	Outcome

Appendix 3: Approval Letter



City of Bulawayo

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Human Capital Director

Human Capital Department
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09 February 2024

Our Reference: FQM/74-00-00

29 November 2024

2009 Mahatshula North
Bulawayo, Zimbabwe

Telephone +263778711988

Dear Ms S Mazivisa

RE: REQUEST FOR PERMISSION TO CARRY OUT RESEARCH ON COUNCIL PREMISES: REQUEST TO CONDUCT A STUDY ON ANALYSIS OF VIRAL LOAD RESPONSE AND ASSOCIATED FACTORS IN CHILDREN LIVING WITH HIV AGED 5-19 YEARS ON ANTI-RETROVIAL THERAPHY AT BULAWAYO CITY ,ZIMBABWE,2021-2023

Your letter on the above matter refers

Please be informed that Council acceded to your request to carry out research within Bulawayo City Council premises subject to the following conditions:

a) You should submit a copy of your research findings after completing the research exercise.
b) Council is to be indemnified against any accidents /mishaps, which may occur during the conduct of the research.
c) The information gathered during research should be used for academic purposes only.

Accordingly you may approach any of Council's Service Departments as appropriate for assistance.

Yours faithfully

HUMAN CAPITAL DIRECTOR

CITY OF BULAWAYO
HUMAN CAPITAL DEPT.

CamScanner

Appendix 4: AUREC Approval

"Investing in Africa's future"

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africau.edu

Ref: AU 3616/25

18 February, 2025

SITHEMBINKOSI MAZIVISA
C/O Africa University
Box 1320
MUTARE

RE: *ANALYSIS OF VIRAL LOAD RESPONSE IN CHILDREN LIVING WITH HIV AGED 5-19 YEARS ON ANTIRETROVIRAL TREATMENT AT 3 BULAWAYO CITY CLINICS, ZIMBABWE, 2021-2023*

Thank you for the above-titled proposal you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC 3616/25
  This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** February 18, 2025
- **EXPIRATION DATE** February 18, 2026
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

Yours Faithfully

MARY CHINZOU
FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE