

Prevalence and determinants of viral load suppression among pregnant women living with HIV, attending first antenatal care visit in South Africa



Ellen Tendai Segula (837872)

Supervisor: Dr. Tendesayi Kufa – Chakezha

Co-supervisor: Dr Nosipho Shangase

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Science in Epidemiology (Infectious Diseases).

Johannesburg, 2025

DECLARATION

I, Ellen Tendai Segula (student number 837872), declare that this research report is my work. It is being submitted for the Degree of [MSc in Epidemiology (Infectious Diseases)] at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



(Signature of candidate)

16th of June 2025 in Johannesburg, South Africa

DEDICATION

I dedicate this work to all those living with HIV and advocating for better health. My heartfelt gratitude goes to my husband for his unwavering support to me. To my mother, you are my strength and inspiration. And to my incredible children, this master degree is for you. I also dedicate this to those who have played an integral role in my journey.

ABSTRACT

Understanding VL suppression among pregnant women living with HIV (PWLHIV) on antiretroviral therapy (ART) at their first antenatal care (ANC) visit is crucial for improving maternal and child health outcomes, as it can reduce the risk of mother-to-child transmission (MTCT) of HIV. The first ANC visit is a critical opportunity for early identification of health needs, initiation of care, and enhanced support for PWLHIV.

This study aimed to estimate the prevalence of VL suppression and identify associated factors among PWLHIV attending their first ANC visit in South Africa. We conducted a secondary data analysis using cross-sectional data from the 2022 ANC HIV Sentinel Survey, focusing on 1,542 PWLHIV on ART at their first ANC visit. We analyzed the prevalence of VL suppression (defined as VL $\leq$ 49 copies/mL) using descriptive statistics. Logistic regression was employed to identify factors independently associated with VL suppression in this population. All analyses were weighted to account for the complex survey design, and clustering at the facility level was considered.

The median age of participants was 31 years. The sample included women from all provinces: Eastern Cape (11.76%), Free State (5.79%), Gauteng (28.65%), KwaZulu-Natal (24.33%), Limpopo (6.16%), Mpumalanga (8.12%), Northern Cape (1.06%), North West (6.45%), and Western Cape (7.68%). The overall prevalence of VL suppression was 65.89% (95% CI: 63%-68%). Young women aged 15-24 years and those who booked ANC in the third trimester had significantly higher odds of unsuppressed VL (OR: 1.75, 95% CI [1.25-2.45], $p=0.001$; OR: 1.96, 95% CI [1.33-2.88], $p<0.001$). PWLHIV on dolutegravir-based regimens had higher odds of VL suppression. Provincial differences were also observed, with all provinces except Western Cape and Northern Cape showing higher odds of unsuppressed VL compared to Gauteng.

The findings underscore the urgent need for targeted interventions to enhance ART adherence and VL monitoring among PWLHIV on ART at first ANC, which is essential for optimizing maternal and child health outcomes in South Africa.

Keywords: VL suppression, Pregnant women living with HIV, ART, ANC

ACKNOWLEDGMENTS

I want to express my heartfelt gratitude to my supervisors, Dr. Tendesayi Kufa-Chakezha and Dr. Nosipho Shangase, for their unwavering support, guidance, and expertise throughout my research. Their insightful feedback, encouragement, and belief in my abilities have been invaluable in shaping the direction and quality of my work. I am truly fortunate to have had the opportunity to learn from their wealth of knowledge and experience. Additionally, I would like to thank the Biostatisticians at the University of Witwatersrand for their invaluable assistance in analyzing and interpreting the data. Their contributions played a significant role in the successful completion of my research, and I am deeply grateful for their unwavering support and guidance that they gave me.

TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ABSTRACT	iii
ACKNOWLEDGMENTS.....	iv
TABLE OF CONTENTS	v
LIST OF TABLES.....	viii
CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW	1
1.0. INTRODUCTION	1
1.1. Background	1
1.2. LITERATURE REVIEW	2
1.2.1 VL and VL Suppression	2
1.2.2 The prevalence of VL suppression among PWLHIV in South Africa	3
1.2.3. Impact of VL suppression during pregnancy.....	5
1.2.4. Impact of ART regimen and timing of ART initiation relative to conception	5
1.2.5 Conceptual Framework.....	7
1.2.5.1.1 Education level	8
1.2.5.1.2 Age.....	8
1.2.5.1.3 Employment status	8
1.2.5.1.4 Mental Health Status	8
1.2.5.1.5 Income level.....	9
1.2.5.1.6 Substance use.....	9
1.2.5.1.7 Adherence to ART	9
1.2.5.1.8 Nondisclosure of HIV Status.....	9
1.2.5.1.9 Treatment exhaustion	9
1.2.5.2 Interpersonal Factors	10
1.2.5.2.1 Social support.....	10
1.2.5.2.2 Partner violence	10
1.2.5.2.3 HIV-related stigma	10
1.2.5.3 Institutional Factors	11
1.2.5.3.1 Access to HIV healthcare	11
1.2.5.3.2 Quality of HIV healthcare.....	11
1.2.5.3.3 Availability of HIV counselling and adherence support	11
1.2.5.4 Community Factors	12
1.2.5.4.1 Community norms and cultural beliefs about HIV/AIDS	12

1.2.5.5 Policy Factors	12
1.2.5.5.1 National PMTCT Policy	12
1.3 Gaps identified in the literature	13
1.4 Problem Statement	13
1.5 Justification	13
1.6 Research Question	14
1.7 Aim	14
1.8 Objectives	14
CHAPTER TWO: METHODS	15
2.1 Study Design	15
2.2 Description of the Primary Study	15
2.3 Study Site of the Current Study	16
2.4 Study Population	16
2.5 Sampling	16
2.6 Data Management	16
2.7 Data Analysis	16
2.7.1 Description of variables and outcomes for the current study	16
Table 1: Description of variables	17
2.7.2 Primary Outcome Analysis	17
2.7.3 Factors Associated with VL Suppression	18
2.7.3.1 Univariable and Multivariable Analysis	18
2.8 Ethical Considerations	19
CHAPTER THREE: RESULTS	20
3.1 Study flow of the participants	20
3.2 Social Demographic Characteristics	21
3.3 VL Suppression	22
3.5 Post-Hoc Power Analysis	28
CHAPTER FOUR: DISCUSSION	29
4.1 Summary of Findings	29
4.2 Strength and Limitations	35
4.3 Conclusion and Recommendations	36
REFERENCES	38
APPENDICES	49
Appendix One: Plagiarism declaration report	49
Appendix Three: Turnitin Report	51
Appendix Four; Primary Study Questionnaire	52

LIST OF FIGURES

Figure 1: The eco-sociological framework of factors that contribute to/or affect VL
uppression in PWLHIV on ART before pregnancy 7

Figure 2: Study Flow of PWLHIV included in the analysis.....20

LIST OF TABLES

Table 1: Description of Variables.....	17
Table 2: Baseline characteristics of the study population	21
Table 3: Prevalence of VL suppression (<50 copies/mL) by key covariates among PWLHIV on ART at 1 st ANC visit, N=1542.....	24
Table 4: Factors associated with unsuppressed VL(>49 copies/mL) among PWLHIV on ART at 1st ANC visit	27

NOMENCLATURE

<:	Less than
>:	Greater than
ANC:	Antenatal Care
ART:	Antiretroviral Therapy
BANC:	Basic antenatal care
CI:	Confidence Interval
DALYs:	Disability-Adjusted Life Years
HCT:	HIV counselling and testing
HIV/AIDS:	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HIV:	Human Immunodeficiency Virus.
LIM:	Lab Information Management System
MSM:	Men who have sex with men
MTCT:	Mother-to-Child Transmission
NDoH:	National Department of Health
NAAT's:	Nucleic Acid Amplification Tests
NICD:	National Institute for Communicable Diseases
OMR:	Optical Mark Recognition
PCR:	Polymerase Chain Reaction
PLHIV:	People Living with HIV
PMTCT:	Prevention of Mother-to-Child Transmission
PrEP:	Pre-Exposure Prophylaxis
PWLHIV:	Pregnant Women Living with HIV
RNA:	Ribonucleic Acid
SABSSM1 VI:	The Sixth South African National HIV Prevalence, Incidence, Behaviour, and Communication Survey
SADC:	Southern African Development Community
SRH:	Sexual and reproductive health
STIs:	Sexually transmitted diseases
TGW:	Transgender women
UNAIDS:	The Joint United Nations Programme on HIV/AIDS
VL:	Viral Load
WHO:	World Health Organization

CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.0. INTRODUCTION

This chapter focuses on the prevalence and determinants of viral load (VL) suppression among pregnant women living with HIV (PWLHIV) who attended their first antenatal care (ANC) visit in South Africa. It discusses the significance of understanding VL suppression in this population, particularly for those who were on antiretroviral therapy (ART) before pregnancy. The chapter presents literature on VL suppression among PWLHIV. The chapter concludes with an outline of the study's research question, aims and objectives.

1.1. Background

South Africa has one of the highest HIV/AIDS prevalence rates in Sub-Saharan Africa (SSA), with an estimated 7.7 million people living with HIV (PLHIV)(1). Among this population, pregnant women are a particularly vulnerable group due to the potential transmission of the virus to their unborn children. In 2020, approximately one-third of pregnant women accessing ANC in South Africa's public health sector were living with HIV(2). In the same year, South Africa accounted for the highest number (26%) of PWLHIV in SSA(3). Additionally, approximately 240,000 of South Africa's population living with HIV were pregnant women (4). In 2024, the proportion of pregnant women in South Africa remained similar to that of 2020, with approximately one-third of pregnant women still living with HIV(5).

Given the high burden of HIV among PWLHIV, ANC attendance is essential for promoting maternal and infant health and well-being(6). ANC comprises curative and preventive care services during pregnancy. Skilled health professionals monitor risk factors and implement appropriate interventions to reduce maternal and neonatal mortality and morbidity(7). Based on an analysis of the effectiveness of various ANC models, the World Health Organization (WHO) recommends a minimum of four antenatal visits(8). ANC services, particularly at the first visit, include screening for health conditions like syphilis and HIV, as well as the initiation of ART for newly diagnosed PWLHIV to prevent vertical transmission(7). In South Africa, the provision of ANC services is of particular importance due to the high prevalence of HIV among pregnant women(9). Basic antenatal care (BANC) services are free at all South African government facilities(7).

The WHO recommends a comprehensive package of ANC services for PWLHIV, including regular monitoring of VL suppression and adherence to ART(10). These services aim to prevent vertical transmission of HIV and optimize maternal health. The South African

National Department of Health (NDoH) has implemented various strategies to ensure that pregnant women receive quality care during pregnancy. At the first antenatal visit, essential services are provided to PWLHIV according to the 2023 Guideline for Vertical Transmission Prevention of Communicable Infection, which include a baseline VL testing, maternal syphilis screening, and the initiation of DTG-based regimen regardless of CD4 count if not already on ART(11,12).

Furthermore, the 2023 Guideline for Vertical Transmission Prevention of Communicable Infections recommends cotrimoxazole prophylaxis for PWLHIV patients with a CD4 count $\leq$ 200 cells/ μ L or those at WHO clinical stage 2, 3, or 4. Cotrimoxazole is prescribed to prevent opportunistic infections. These medications are prescribed for PWLHIV with advanced HIV (11,12). As part of comprehensive ANC services, healthcare providers offer counselling to ensure that women understand the importance of adhering to their ART regimen, the potential side effects, and the necessity of regular follow-up visits(11). These comprehensive services aim to optimize maternal health and minimize the risk of vertical transmission of HIV to the infant.

1.2. LITERATURE REVIEW.

1.2.1 VL and VL Suppression

HIV VL testing, a measure of the amount of virus present in an individual's bloodstream, plays a critical role in monitoring the effectiveness of ART(13). Achieving VL suppression, defined as VL at levels < 50 copies/mL, is the primary goal of ART(14). Numerous studies have demonstrated the importance of VL suppression in improving the health outcomes of individuals living with HIV, including reducing the risk of disease progression, transmission, and mortality(15). The literature reviewed in this study consistently highlights the significance of regular VL monitoring and adherence to ART regimens to achieve and sustain VL suppression, thereby ensuring optimal disease management and public health outcomes(16).

Globally, the rates of viral suppression vary across regions and population groups. According to UNAIDS 2023 data, approximately 39.9 million people were living with HIV globally, with women and girls accounting for 53% of this population(17). Among all PLHIV, 86% knew their HIV status, 77% were accessing ART, and 72% were virally suppressed (17). However, these global averages conceal significant disparities across population groups. Women tend to have better treatment outcomes than men. Among women aged 15 and above, 91% knew their status, 91% were on ART, and 94% were virally suppressed(18). In contrast, only 83% of men

in the same age group knew their status, 86% were on treatment, and 94% were virally suppressed(17). Key populations such as men who have sex with men, sex workers, transgender people, and people who inject drugs continue to experience disproportionately higher HIV prevalence and face persistent barriers to testing, treatment, and viral suppression(17). Among pregnant women, VL suppression is critical to elimination of vertical HIV transmission. In 2023, 84% of PWLHIV globally had access to ART, reflecting continued progress(18). However, viral suppression data for this subgroup remains incomplete globally, with wide variation in program effectiveness and monitoring capacity across countries(17).

In South Africa, the country with the largest HIV epidemic globally, progress toward VL suppression has been substantial but uneven. As of 2020, national data indicate that about 66% of PLHIV on ART were virally suppressed, though this figure is lower among adolescents, young adults, and newly diagnosed individuals(18). Among PWLHIV, VL suppression is estimated at around 63.3%, with lower rates observed in those newly diagnosed during pregnancy or those restarting ART after prior disengagement from care(19). Furthermore, in South Africa, the optimal timing of VL testing for PWHIV is based on their ART status. For women who initiate or re-initiate ART during pregnancy, the first VL test is to be done three months after starting treatment, and if suppressed, a repeat test is scheduled at delivery(20). For those already on ART at the time of antenatal booking, a VL test is done at the first ANC visit and repeated at delivery, unless non-suppression is suspected(20). If ART is initiated after 28 weeks' gestation, a VL test is to be done at delivery and repeated three months postpartum, aligned with the infant's 10-week immunisation visit(20). Additionally, all women, regardless of ART history or breastfeeding status, are to have a VL test at six months postpartum, aligned with the infant's six-month immunisation visit(20). Despite these scheduled time points, challenges such as inconsistent implementation, poor documentation, delayed results, weak coordination between ANC and delivery services, and inadequate follow-up of elevated VL especially among breastfeeding mothers are expected to limit the effectiveness of VL monitoring.

1.2.2 The prevalence of VL suppression among PWLHIV in South Africa

Access to ART has substantially increased since the national ART program began in 2004. From 2019 to 2024, approximately 97% of PWLHIV in South Africa were on ART(4,21). This achievement is commendable as ART plays a vital role in prevention of vertical HIV transmission of HIV and in improving the overall health of pregnant women.

However, although the coverage of ART among pregnant women has greatly increased, reports show low VL suppression among those receiving ART (9).

A study examining maternal VL during pregnancy and postpartum among women living with HIV found that, despite substantial ART coverage, only 63% of pregnant women achieved a VL below 50 copies/mL at delivery(22). This indicates that a significant proportion of pregnant women may still have high VL, posing a potential risk to their health and the transmission of the virus to their infants.

The antenatal HIV sentinel surveys conducted in 2017 and 2019 showed notable improvements in HIV awareness and treatment. However, viral suppression (<50 copies/ml) among PWLHIV receiving ART remained a concern, with figures estimated at 64.2% in 2017 and 66.0% in 2019(9). Furthermore, the achievement of the Joint United Nations Programme on HIV/AIDS (UNAIDS) third 95 target, which aims for 95% of individuals on ART to achieve viral suppression, varied significantly by province. In 2017, this ranged from 33.9% to 72.6%, while in 2019, it improved slightly to between 43.4% and 77.3%(9). Notably, newly diagnosed pregnant women and those reinitiating ART play a critical role in these outcomes. These groups often begin treatment late in pregnancy, leaving limited time to achieve full VL suppression by delivery(23). In addition, they may face greater psychosocial and structural barriers, such as poor adherence, stigma, or delayed ANC attendance, which compromise treatment outcomes. Research has shown that VL suppression is significantly lower among newly initiated ART users during pregnancy compared to those who entered pregnancy already virally suppressed(24). Similarly, women who have previously defaulted and are restarting ART may present with drug resistance or adherence difficulties that further hinder viral suppression(23). These challenges underscore the need for differentiated care strategies, early HIV testing, enhanced adherence support, and rapid ART initiation, especially among newly diagnosed or reinitiating pregnant women, to reduce vertical transmission risk and improve maternal outcomes.

However, according to the 2022 ANC survey report, there has been progress, with 74.1% of PWLHIV achieving viral suppression(25). This reflects ongoing efforts to improve ART accessibility and effectiveness, though challenges remain in ensuring consistent care and support across regions.

1.2.3. Impact of VL suppression during pregnancy

Research has highlighted the improved health outcomes of infants born to mothers with suppressed VLs. In the context of pregnancy, delivery, and/or breastfeeding, when the mother achieves VL suppression, Mother-to-Child Transmission (MTCT) is extremely unlikely to occur, to the extent that the risk drops to less than 1%, thus reducing the infant's risk of contracting HIV(26). Reduced risk of MTCT leads to improved immune system development and overall health outcomes of the infant compared to infants born to mothers with uncontrolled VLs(14,19).

High maternal VL has a substantial effect on the health outcomes of infants born to women living with HIV(28). Studies have shown a clear correlation between maternal VL and the risk of perinatal complications, including low birth weight, prematurity, and neonatal mortality(29). A study by Kebede et al., (2013) demonstrated that infants born to mothers with unsuppressed VL had an increased risk of low birth weight and preterm delivery, compared to those born to mothers with suppressed VLs(29). Also, Concepcion et al., (2020) discovered that infants born to mothers with unsuppressed VL had high odds of preterm birth, which is a major cause of neonatal mortality and morbidity(30).

1.2.4. Impact of ART regimen and timing of ART initiation relative to conception

Some studies have provided valuable insights into the effectiveness of different ART regimens for preventing MTCT. For instance, the PROMISE study compared different ART regimens for preventing MTCT and found that the transmission rate was 0.5% among women whose VL at delivery was less than 200 copies/mL with triple-drug ART and 1.8% with zidovudine monotherapy(31). Furthermore, supporting the importance of early treatment, the HPTN 052 study found that early ART initiation significantly reduced the risk of MTCT in PWLHIV. For instance, at one year postpartum, the transmission rate was just 0.5% among women whose VL was <400 copies/mL at the beginning of ART compared to significantly higher transmission rates among those who initiated ART later or had unsuppressed VLs(32).

The advantage of reducing the risk of MTCT that comes with being on ART at the time of conception is well-documented in scientific literature. Mandelbrot et al. (2015), aimed to assess the possibility of eliminating MTCT of HIV by initiating highly active ART before conception. The study found that no transmission occurred among 2651 infants born to women who were already on ART at the time of conception and maintained viral suppression throughout pregnancy(33). Initiating ART before conception improves the overall mother's health by

limiting the HIV infection's progression and reducing the risk of opportunistic infections(34). For mothers who breastfeed, ART provides ongoing protection against MTCT throughout the breastfeeding period(34).

In South Africa, the preferred ART regimen for PWLHIV is TLD, which includes tenofovir disoproxil fumarate (TDF), lamivudine (3TC), and dolutegravir (DTG)(35). When DTG is not appropriate, other regimens include TDF, 3TC, and efavirenz (EFV); TDF, emtricitabine (FTC), and EFV; and abacavir (ABC), 3TC, and EFV. For second-line treatment, zidovudine (AZT), 3TC, and lopinavir/ritonavir (LPV/r) are used(35). Third-line options may include darunavir/ritonavir (DRV/r) and raltegravir (RAL)(36).

1.2.5 Conceptual Framework

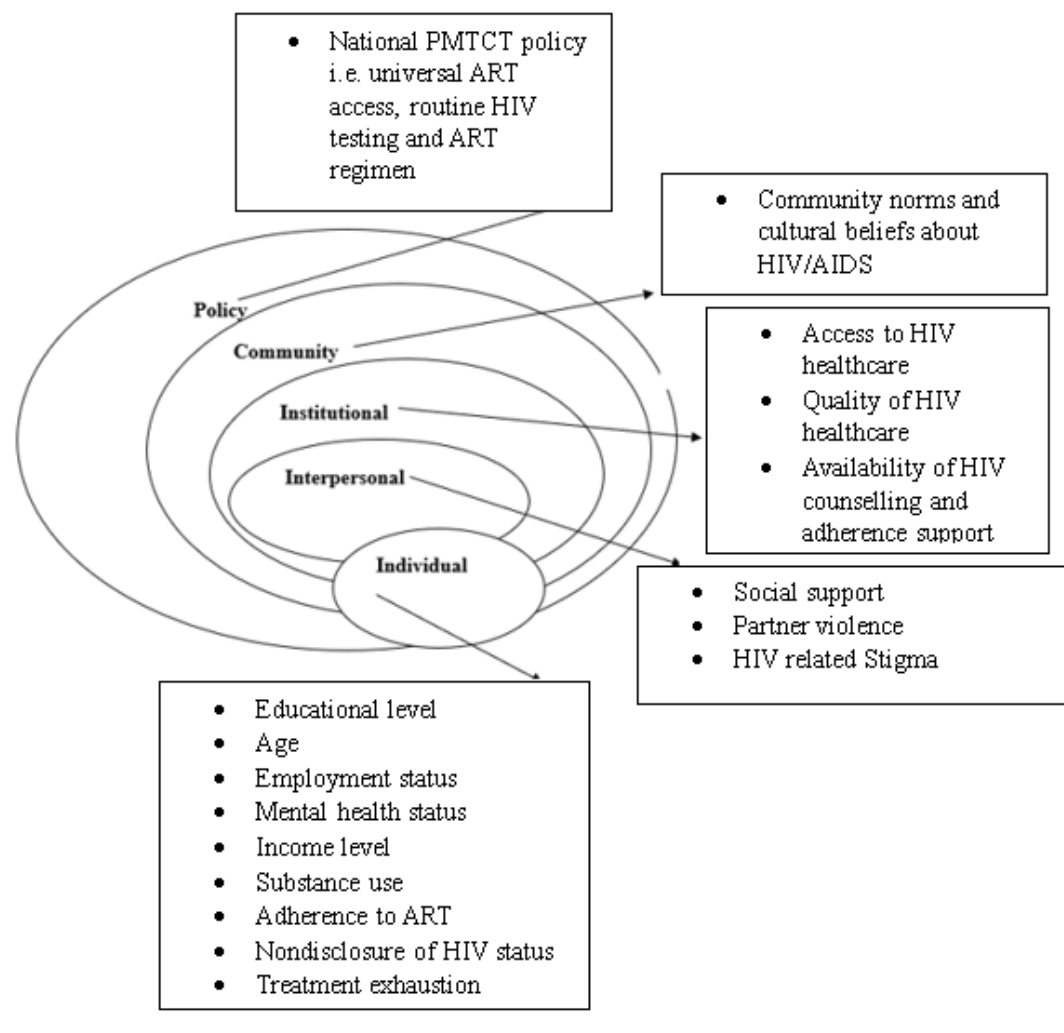


Figure 1: The eco-sociological framework of factors that contribute to or affect VL suppression in PWLHIV on ART before pregnancy

Various factors can influence VL suppression among PWLHIV on ART before pregnancy (see Figure 1). These factors can be categorized into individual, interpersonal, institutional, community and policy factors.

1.2.5.1 Individual Factors

1.2.5.1.1 Education level

Several studies have identified a correlation between lower levels of maternal education and a reduced likelihood of receiving ART and adhering to ART(37,38). The education level of PWLHIV can affect VL suppression in several ways. Higher education levels are associated with better health literacy, knowledge, and awareness of HIV and VL suppression(16,39). PWLHIV with higher education levels are more likely to understand the importance of adherence to medication and engagement in healthcare services, leading to improved outcomes(16). Education also empowers individuals to take an active role in managing their health and provides better access to resources necessary for VL suppression(16).

1.2.5.1.2 Age

In the early 2000s, most studies observed no significant correlation between maternal age and the uptake of ART (40). However, more recent research has identified a notable association between these variables. Younger age (<25 years) is associated with failure to achieve viral suppression(15). Younger women are less likely to receive and adhere to ART(41,42). Furthermore, younger pregnant women may face challenges in accessing healthcare services and may have limited knowledge about ART(22).

1.2.5.1.3 Employment status

Employment status can influence VL suppression. Due to financial constraints, unemployed women must deal with several issues, including inadequate food security and the expense of transportation to ART clinics(43). A study conducted by Adeniyi et al., (2021) in the Eastern Cape to examine factors associated with peripartum virologic suppression found that unemployment significantly reduces the likelihood of peripartum virologic suppression(39). Another study found that women who are unemployed and depend on their spouse or partner for financial support have a high prevalence of unsuppressed VL(15).

1.2.5.1.4 Mental Health Status

Mental health plays a crucial role in VL suppression. Pregnant women who experience mental health issues such as depression, denial of their HIV status at ANC, anxiety or stress, may find it challenging to adhere to their medication regimen consistently(44–46). Mental health conditions can also impact a person's overall well-being and motivation to engage in self-care practices necessary for VL suppression(30).

1.2.5.1.5 Income level

Income level is another significant factor that affects VL suppression. Low income level is associated with poorer response to ART(47). Limited financial resources can impact a person's access to nutritious food, transportation to medical appointments to pick up free medications from the clinic, and other essential resources for maintaining good health and VL suppression(48).

1.2.5.1.6 Substance use

Substance use, including alcohol and drug abuse, can hinder VL suppression. Alcohol use can negatively impact ART adherence and overall health(49). For instance, substance use can impair cognition, leading to forgetfulness and poor decision-making about ART, with pregnant women less likely to prioritise it, resulting in suboptimal VL suppression (49,50).

1.2.5.1.7 Adherence to ART

Poor adherence to ART medications can result in incomplete VL suppression(51). Pregnant women who struggle with adhering to their prescribed medication regimen may experience fluctuations in VL levels, risking non-suppression(52). Adherence to ART may be further compromised by lifestyle behaviours, side effects of ART, and ongoing fear of stigma, particularly when HIV status has not been disclosed or when facing interpersonal violence and lack of partner support(52).

1.2.5.1.8 Nondisclosure of HIV Status

Nondisclosure of HIV status can hinder VL suppression during pregnancy. Pregnant women who do not disclose their HIV status to their partners, family members and friends may miss out on necessary support and interventions to optimize VL suppression(51).

1.2.5.1.9 Treatment exhaustion

Treatment exhaustion can lead to decreased motivation and disengagement in self-care practices necessary for VL suppression(55). ART requires lifelong commitment and entails various lifestyle adjustments. These adjustments include integrating medication intake into daily routines, coping with potential side effects, consistently obtaining prescription refills, attending medical appointments, and remembering to take medications consistently for a patient's life(55). ART treatment fatigue can lead to a decline in adherence over time(55). PWLHIV may experience a pill burden and become exhausted from the demands of long-term treatment, hence failing to achieve VL suppression(56).

1.2.5.2 Interpersonal Factors

1.2.5.2.1 Social support

Social support significantly impacts maternal health and well-being during pregnancy(44). Women with social support from their partners or family members are more likely to achieve viral suppression than those who don't have support(57,58). Having supportive relationships with partners, family members, friends, or support groups can positively influence VL suppression outcomes(58–60). Social support plays a crucial role in providing emotional, practical, and informational assistance to individuals living with HIV(57). Supportive relationships can help reduce stress, enhance medication adherence, encourage regular medical visits, and provide a sense of belonging and acceptance, all of which contribute to better VL suppression(57,61). Contrary to the aforementioned studies, other studies found no correlation between social support and ART uptake(62,63), nor any significant association between social support and VL suppression among PWLHIV(43).

1.2.5.2.2 Partner violence

The likelihood of achieving VL suppression is lower in women who experience intimate partner abuse(15). Hatcher et al., (2021) investigated the long-term association between partner violence and HIV VL suppression during pregnancy and the postpartum period. The study found that exposure to partner violence during pregnancy was not associated with VL suppression but was associated with a decreased likelihood of viral suppression at 12 months postpartum(64). The stress and trauma associated with partner violence can negatively impact adherence to ART and engagement in HIV care(15). Fear of disclosure or retaliation from an abusive partner can make it difficult for women to consistently take their medication or attend medical appointments, leading to suboptimal VL suppression outcomes(15).

1.2.5.2.3 HIV-related stigma

The stigma surrounding HIV can create barriers to achieving VL suppression. PWLHIV often face discrimination, judgment, and social exclusion, which can negatively impact their mental health and well-being(65). HIV-related stigma may deter individuals from seeking HIV testing, initiating ART, or adhering to their treatment regimen(54,66,67). Stigma can also lead to feelings of shame or self-blame, anxiety, suicidal ideation, psychological distress, and depression which may further hinder engagement in care and VL suppression(68–70).

1.2.5.3 Institutional Factors

1.2.5.3.1 Access to HIV healthcare

The accessibility and availability of HIV healthcare services can greatly influence VL suppression. In South Africa, ANC services are free at all public health facilities(2).

However, financial constraints prevent PWLHIV from accessing ANC and ART services and later on can lead to VL non-suppression(60,71–73). Furthermore, limited access to healthcare facilities, especially in rural or remote areas, creates obstacles for PLHIV, including PWLHIV in obtaining regular HIV testing, treatment, and follow-up care (72,74). Lack of nearby healthcare facilities or long-distance travel can be particularly burdensome for PWLHIV. Additionally, the felt need to travel outside their community to a clinic to avoid stigma can impact their treatment adherence, ultimately affecting VL suppression(74).

1.2.5.3.2 Quality of HIV healthcare

The quality of HIV care provided by healthcare institutions is crucial for VL suppression(75). South Africa has made substantial strides in enhancing the quality of HIV care, particularly through the prevention of vertical HIV transmission program. Most pregnant women attend at least one ANC visit, and a large proportion meet the recommended four-visit schedule(2). High levels of HIV testing and ART provision during pregnancy and delivery have been achieved(2). However, challenges persist in ensuring consistent quality care. Factors such as ANC staff attitudes, availability of trained healthcare professionals, adherence to treatment guidelines, availability of essential medications, and regular monitoring of VL and CD4 counts are necessary for effective HIV management(76). Inadequate training, resource limitations, and suboptimal clinical practices can compromise the quality of care, resulting in poor VL suppression outcomes(76). Furthermore, patient-related barriers and health-system factors, such as crowded clinics, contribute to women seeking ANC later in their pregnancy(91,46). Delays in ANC initiation can, in turn, delay ART initiation particularly for newly diagnosed women or those reinitiating ART after treatment interruption ultimately reducing the likelihood of timely VL suppression(77).

1.2.5.3.3 Availability of HIV counselling and adherence support

Counselling and adherence support services play a vital role in helping individuals understand the importance of ART adherence and providing strategies to overcome barriers(78,79). In South Africa, HIV counselling and testing (HCT) is free at all public facilities, with national guidelines mandating HCT for all pregnant women at their first ANC visit(7). The availability of trained counsellors and support groups can positively impact adherence rates and ultimately

contribute to VL suppression(78). PWLHIV requires counselling to alleviate their mental stress and build their self-esteem(79). Lack of counselling services and limited support can lead to difficulties in adhering to medication regimens, resulting in suboptimal viral suppression(78).

1.2.5.4 Community Factors

1.2.5.4.1 Community norms and cultural beliefs about HIV/AIDS

Stigmatizing attitudes or misconceptions about HIV/AIDS within a community can create barriers for all PLHIV to discuss their HIV status openly, seek medical care, and adhere to their ART regimen(45,78,80,81). Negative community attitudes can lead to fear of discrimination, social isolation, and reluctance to access healthcare services, ultimately hindering VL suppression(45,78,82). HIV-related discrimination and stigma can significantly impact VL suppression. PWLHIV who experience discrimination or stigma due to their HIV status may feel ashamed, marginalized, and afraid to disclose their status or seek healthcare services(82). Fear of judgment and rejection can lead to non-disclosure of HIV status and reluctance to engage in HIV care, resulting in suboptimal ART adherence and VL suppression(46,54,67,78,82).

1.2.5.5 Policy Factors

Policies are instrumental in enhancing the VL suppression among PWLHIV. Policies such as the National prevention of vertical HIV transmission i.e. prevention of vertical HIV transmission Option B Plus strategy, universal ART access, and routine HIV testing during ANC visits, contribute to better VL suppression outcomes(83).

1.2.5.5.1 National PMTCT Policy

The National prevention of vertical HIV transmission policy encompasses a set of guidelines and strategies implemented at national level to prevent the MTCT of HIV(83). One crucial element of this policy is the Option B Plus strategy and universal access to ART for PWLHIV. The prevention of vertical HIV transmission Option B Plus strategy was implemented in South Africa in January 2015(84). This strategy involves the provision of lifelong ART to PWLHIV, irrespective of their CD4 count or clinical disease severity(85,86). The aim is to ensure that all PWLHIV receive ART to improve their health outcomes and prevent vertical transmission(84). The introduction of the Option B Plus strategy has significantly improved access to ART for PWLHIV in the South African public health sector(84,86,87). As a result, more than 95% of women with unknown HIV status are now tested for HIV during ANC visits, enabling early

identification of PWLHIV(88). Moreover, as of 2015, more than 90% of PWLHIV were receiving ART through this policy(88).

1.3 Gaps identified in the literature

The existing literature reveals gaps in our understanding of treatment among PWLHIV. Firstly, despite the widespread ART distribution, the high prevalence of HIV among antenatal women suggests that factors affecting VL suppression require further investigation. Secondly, while ART coverage is substantial, the low proportion of PWLHIV achieving viral suppression underscores the need for targeted research concerning the factors influencing this outcome. Addressing these gaps is essential for improving health outcomes and minimizing the risk of infant transmission. Although many factors affect VL suppression, only a few have been investigated by the current study, considering that not all aspects were covered during data collection.

1.4 Problem Statement

Previous research has focused on various aspects of HIV care and treatment during pregnancy, including ART initiation, adherence, and PMTCT. However, achieving VL suppression among PWLHIV remains problematic(89). VL suppression is important for improving quality of life, reducing mortality and morbidity for PLWHIV, as well as reducing MTCT during pregnancy(90). The third pillar of the elimination of vertical HIV transmission strategy aims to prevent transmission of HIV from PWLHIV to their infants. This can best be achieved by ensuring that women of reproductive age are already on ART and virally suppressed at conception and that they maintain this viral suppression during pregnancy. In South Africa, there is limited knowledge about viral suppression in pregnant women on ART before the current pregnancy.

1.5 Justification

While several studies have examined VL suppression among PWLHIV in South Africa, there is limited research specifically focusing on women attending ANC for the first time and who were already on ART before pregnancy. This group represents a distinct subset of the pregnant population, as they have already initiated ART and are likely to have been on treatment for a longer duration compared to those starting ART during pregnancy, and are expected to have achieved viral suppression. Furthermore, this group is an increasing proportion of pregnant women and may reflect VL suppression at conception. This has been associated with the lowest risk of MTCT in studies. Understanding the factors associated with VL suppression in this

specific population is crucial for developing targeted interventions for improving maternal and child health outcomes. Similarly, it may enhance care during the transition from adult HIV services to antenatal care services.

The purpose of this study is to evaluate VL suppression and factors related to VL suppression in PWLHIV who were on ART before becoming pregnant and were attending ANC for the first time. This research will help identify areas for improvement and offer important insights into the efficacy of current PMTCT programs. Additionally, the findings will have an impact on practice and policy, enhancing the quality of ANC services and reducing the prevalence of HIV among pregnant women and children in South Africa.

1.6 Research Question

What is the prevalence of VL suppression among PWLHIV who attended their first ANC visit in South African public health facilities and were on ART before pregnancy, and what factors are associated with this suppression?

1.7 Aim

To estimate the prevalence of VL suppression among PWLHIV who attended their first ANC visit in South African public health facilities and were on ART before pregnancy.

1.8 Objectives

- i. To estimate the prevalence of VL suppression among PWLHIV who attended their first ANC visit and were on ART before pregnancy.
- ii. To describe the prevalence of VL suppression by key covariates such as age, province, and regimen type among PWLHIV who attended their first ANC visit and were on ART before pregnancy.
- iii. To identify factors independently associated with VL suppression among PWLHIV who attended their first ANC visit and were on ART before pregnancy.

CHAPTER TWO: METHODS

This chapter describes the study design. It covers the study site, the study population, sampling, data management, data analysis, and ethical considerations.

2.1 Study Design

The study employs secondary data analysis using cross-sectional data collected during the South African 2022 ANC HIV sentinel survey (primary study).

2.2 Description of the Primary Study

The primary study was a national cross-sectional sentinel survey conducted from February to April 2022. The survey aimed to determine HIV seroprevalence among pregnant women aged 15 to 49 attending South African ANC clinics. The survey also aimed to track trends and establish the geographical distribution and pattern of HIV prevalence among these women over time, as well as to track the progress toward the 95-95-95 targets for pregnant women.

The sentinel sites were classified based on their geographical location and size, providing up to nine strata per district. Eight to eighty-three institutions were chosen for every district. The primary sampling unit was public health facilities providing ANC services in the previous three months. The primary data was collected using a paper-based data collection form, which included demographic indicators such as race, marital status, age and type of antenatal visit. Participants were provided an information sheet, with trained nurses explaining to them the information therein. Furthermore, they were given opportunity to ask the nurses questions and to give written consent for their participation in the study. First-time or follow-up attendees underwent a brief interview and had a blood specimen collected. Demographic data were abstracted from registers, for reporting purposes, for those who did not provide consent, in accordance with ethical guidelines.

Forms were scanned and captured using Optical Mark Recognition (OMR), and regular quality checks and validation procedures were implemented to maintain data integrity. The study used OMR to convert paper data into an electronic database managed by the National Institute for Communicable Diseases (NICD). Data from the HIV-related testing of collected samples were entered into TrakCare (the laboratory information system at NICD) and downloaded weekly. The data was regularly reviewed for quality and completeness, and stored securely on an NICD server with restricted access and online protection for viruses.

2.3 Study Site of the Current Study

This study used data collected from all 1,595 ANC sentinel survey sites across the nine South African provinces that participated in the 2022 survey.

2.4 Study Population

The study population was composed by PWLHIV who received ART before becoming pregnant, who were in the 15 to 49 age range, who participated in the 2022 ANC HIV Sentinel Survey, and who were attending their 1st ANC visit at the time of the survey.

2.5 Sampling

All PWLHIV who met the eligibility criteria for the secondary analysis were included.

2.6 Data Management

The 2022 ANC survey de-identified dataset was received from the study's principal investigator in DTA format, following the receipt of ethical clearance. The data was stored on a password-protected personal computer, and access to the raw data was restricted to only those directly involved in the research.

2.7 Data Analysis

The analysis was conducted using StataCorp. 2021. Stata Statistical Software: Release 17. College Station, TX: StataCorp LLC(91), with the support of supervisors and the supervision of statisticians from the University of Witwatersrand.

2.7.1 Description of variables and outcomes for the current study

The dependent variable (outcome) was VL suppression, which was defined as VL of less than 50 copies per millilitre (See Table 1 for the description of variables). The use of <50 copies/mL as the cut-off point for viral suppression was supported by robust scientific evidence, demonstrating its association with reduced transmission risk and improved health outcomes(92,93). The South African NDoH guidelines also recommend this threshold. The main exposure variable is ART status before pregnancy, defined as being on ART prior to conception and at the time of the first ANC visit. These variable captures whether the participant-initiated ART before pregnancy, in line with the inclusion criteria for the study. Other independent variables considered include maternal age, province, gestational age at first ANC visit, ART regimen type, and time on ART. These variables are included to identify factors that may be associated with VL suppression among pregnant women living with HIV (PWLHIV).

Table 1: Description of variables

The dependent Variable (outcome)	Exposure variable	Explanatory variables	Variable type
VL suppression (<50 copies/ML)	ART status before pregnancy	• Agegroup: 15-24, 25-34 and 35-49 • Race: African, Asian, Coloured, White and other • Education level: None/Primary, Secondary and Tertiary • Trimester at booking: First trimester, Second trimester and Third trimester • Parity: None, One/Two and Three or more times • Regimen type: Dolutegravir (DTG)-based (TLD) , Efavirenz (EFV)-based and Second line • Gravidity: Once, Twice and Three or more times • Partners age: 16-24,25-34 and 35-74 • Syphilis status: Positive, Negative and Missing • Knowledge of partner's status: • Sex under the influence of drugs or alcohol: Yes, No and Missing • Relationship with the partner who fathered the infant: Married and other(Living together/co-habiting , Not living together but in a relationship and No relationship) • Multiple sexual partners: One sexual partner, More than one sexual partner and Missing	• Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical • Categorical

2.7.2 Primary Outcome Analysis

The secondary analysis included PWLHIV women whose outcome and main exposure data were available. Objective 1 sought to estimate the prevalence of VL suppression among PWLHIV who attended their first ANC visit and were on ART before pregnancy. Objective 2 endeavoured to describe the prevalence of VL suppression by key covariates such as age, province, and ART regimen type. For these objectives, data were summarized using descriptive and summary statistics, with proportions expressed for categorical variables such as age groups, provinces, and ART regimens. The prevalence of VL suppression was determined by calculating the proportion of individuals with a VL threshold of <50 copies/mL.

Descriptive analyses were conducted to determine the proportion of PWLHIV who had VL suppression. The proportion of PWLHIV who had VL suppression was also determined by main demographic indicators such as age group (15–24, 25–34, and 35–49 years), level of education (none/ primary, secondary, and tertiary), race (Other [Coloured, White, and Asian] and Black African), parity, relationship with the father of the child, regimen type and partner age among others. The normal approximation to the binomial distribution was used to compute

95% confidence intervals (CI) for the prevalence of VL suppression to provide a measure of the estimate's precision.

2.7.3 Factors Associated with VL Suppression

2.7.3.1 Univariable and Multivariable Analysis

To address objective 3, factors associated with unsuppressed VL were assessed using univariable and multivariable logistic regression analysis. Both analyses accounted for the survey design. Statistical significance for interpretation of the results in the final model was defined at a 5% level ($p < 0.05$).

A systematic model selection process was employed to examine factors associated with unsuppressed VL. Bivariable logistic regression analysis of all variables was performed, including variables that had p-values less than 0.2 in the final multivariable logistic regression model. This liberal threshold ($p < 0.2$) was intentionally used to avoid excluding potentially important predictors too early in the analysis. Importantly, while a p-value of < 0.2 was used as a screening threshold for variable selection, statistical significance in the final model was assessed at the conventional $p < 0.05$ level, ensuring that the conclusions drawn were based on a rigorous standard of evidence. Variables included were age group, trimester at booking, province, ART regimen type, partner age, and relationship with the father. Some variables were also retained in the model based on theoretical importance or prior evidence of their association with viral suppression. For instance, education was retained in the model despite a P-value of > 0.2 due to evidence from other studies suggesting a potential association with VL suppression in PWLHIV(16).

After fitting the multivariable logistic regression model, multicollinearity was assessed using the Variance Inflation Factor (VIF), which indicated that no variables had a VIF greater than 10, suggesting that multicollinearity was not an issue. Correlations among predictors were assessed but none was established, confirming the independence of the included variables. In addition, interaction terms were included in the final model to explore potential moderating effects among predictors. The final model was evaluated for goodness of fit, and performance metrics were assessed to confirm its robustness.

The multivariable logistic regression analysis identified several factors significantly associated with unsuppressed VL among PWLHIV on ART at their first ANC visit, building upon results

of the bi-variable analysis. Significant predictors included age group, ART regimen type, province, and trimester at booking, each interpreted in terms of the odds ratio. This comprehensive approach enhanced the findings' reliability and ensured that the conclusions were firmly grounded in rigorous statistical frameworks.

2.8 Ethical Considerations

The study followed ethical principles outlined in Singapore's statement on research integrity, emphasizing honesty, fairness, and good stewardship(94). The University of Witwatersrand Human Research Ethics Committee (Medical) approved this study, clearance certificate number M240319 M240520-D-0001 (see appendix 1). De-identified data was received from the PI of the ANC survey, Professor Puren. Only the researchers actively involved in the study could access the raw data.

CHAPTER THREE: RESULTS

This chapter outlines the study flow, the sociodemographic characteristics of the study population, post-hoc power analysis, and the study results.

3.1 Study flow of the participants

A total of 42,875 PWLHIV were initially enrolled in the survey (see Figure 2). However, 6,178 individuals were excluded for various reasons. Of these, 64 (0.1%) individuals were outside the specified age range of 15-49 years, and 777 (1.8%) individuals had missing age data. Additionally, 1,492 (3.5%) individuals were excluded because no blood sample was collected, while 2,314 (5.4%) had their specimens rejected. There were also 111 (0.3%) individuals whose data collection forms were lost, and 289 (0.7%) individuals whose specimens were lost. Furthermore, 1,131 (2.6%) individuals were excluded due to a lack of documented consent in the files. Among those who agreed to participate but were excluded from the analysis, 21(0.06%) were not pregnant, 26 283 (71.66%) were HIV negative, 4380 (42.14%) were not on ART before pregnancy, 83 (1.38%) had no VL results available and 4388 (72.98%) were not first time ANC attendees. This resulted in 1542 (25.64%) participants being included in the analysis.

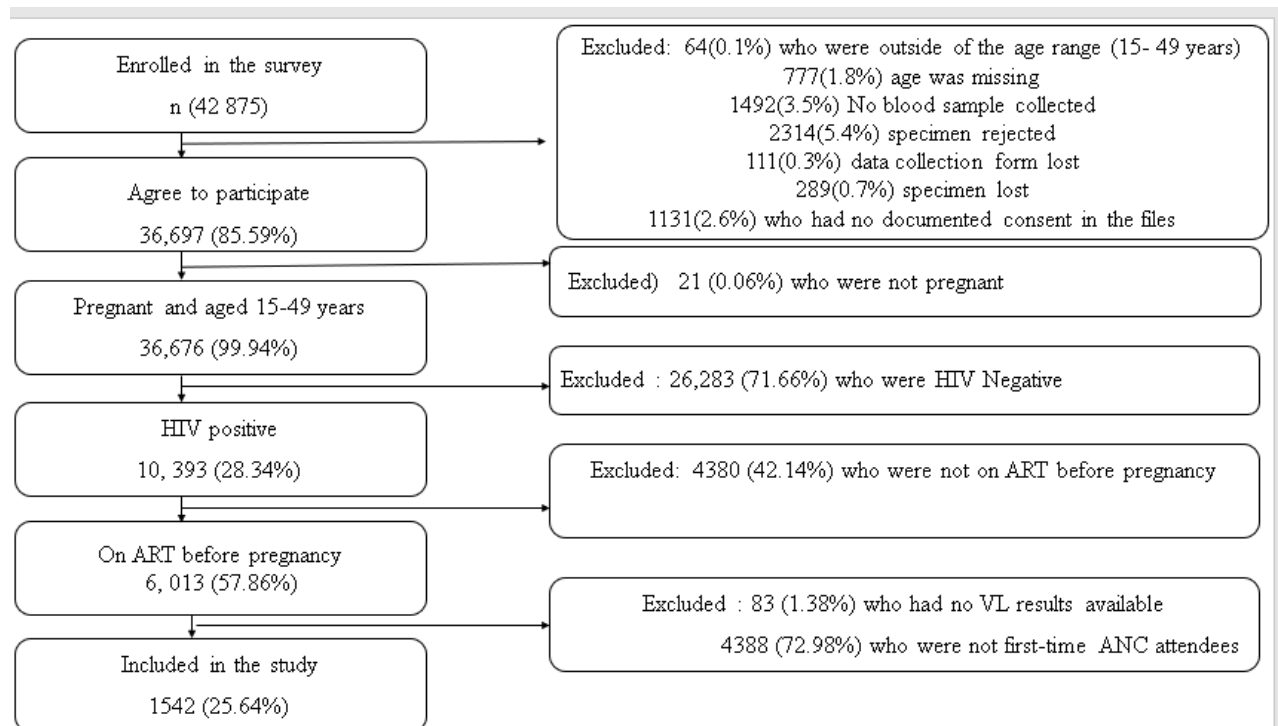


Figure 2: Study Flow of PWLHIV included in the analysis

3.2 Social Demographic Characteristics

The study analysed a sample of 1,542 PWLHIV (see Table 2). The mean age of participants was 31.02 years (standard deviation [SD]5.97). The median age was 31, with an interquartile range of 27-35 years. Among the participants, 15.43% were aged 15-24. Most participants were African (96.91%). Educational attainment varied, with 11.94% having no formal education or only primary schooling and 76.16% having completed secondary education.

In terms of relationship status, only 15.42% were married. Geographically, most PWLHIV were from KwaZulu-Natal, comprising 30.22% of the sample. Notably, Gauteng and Kwazulu-Natal exhibited adjusted and unadjusted differences of more than 5%, which means these two provinces were over-represented in the dataset. This over-representation suggests that the findings may disproportionately reflect these provinces and caution should be taken when applying the results to populations from other provinces with lower representation.

Regarding parity, 13.89% had no previous children. Regarding gravidity, 10.51% were pregnant for the first time, while 62.27% had experienced three or more pregnancies.

Concerning partner HIV status, 45.45% had partners who were HIV positive. A small proportion (0.63%) reported not having a sexual partner, with 52.01% of data missing. The majority of PWLHIV were on the DTG regimen (59.18%). The prevalence of syphilis was 2.02%, though testing data was missing for 59.51% of the sample.

Regarding gestational age at first antenatal booking, most participants (57.92%) initiated care during the second trimester, while 33.01% booked during the first trimester, and 9.07% in the third trimester. This highlights the importance of encouraging earlier engagement with antenatal services for optimal maternal and child health outcomes.

Table 2: Baseline characteristics of the study population (N= 1542)

Characteristics	Total (N = 1542)	Unweighted, %	Weighted, % [95% CI]
Age (years), IQR (median)	-	27-35 (31)	27-35 (31)
15-24	244	15.82	15.43 [14.06-16.91]
25-34	853	55.32	54.95 [52.9-56.99]
35-49	445	28.86	29.62 [27.78-31.52]
Race			
African	1488	96.81	96.9 [96.22-97.47]
Other races	49	3.19	3.09 [2.51-3.78]
Education level			
None/Primary	183	12.02	11.94 [10.6-13.43]
Secondary	1160	76.22	76.16 [74.33-77.9]
Tertiary	179	11.76	11.9 [10.59-13.34]
Relationship with the father			
Married	224	14.66	15.42 [13.9-17.07]
Living together/co-habiting	448	29.32	31.44 [29.47-33.47]

Not living together but in a relationship	817	53.47	50.63 [48.55-52.7]
No relationship	39	2.55	2.52 [1.98-3.20]
Province			
Eastern Cape	246	15.95	11.76 [10.76-12.89]
Free State	136	8.82	5.79 [5.15-6.50]
Gauteng	225	14.59	28.65 [26.46-30.94]
Kwazulu-Natal	466	30.22	24.33 [22.52-26.23]
Limpopo	88	5.71	6.16 [5.56-6.81]
Mpumalanga	139	9.01	8.12 [7.13-9.23]
Northern Cape	34	2.20	1.06 [0.81-1.38]
North West	104	6.74	6.45 [5.33-7.78]
Western Cape	104	6.74	7.68 [6.97-8.45]
Parity			
None	216	14.13	13.89 [12.66-15.21]
One	490	32.05	31.71 [29.84-33.64]
Two	460	30.09	29.9 [28.02-31.86]
Three or more	233	23.74	24.5 [22.7-26.39]
Gravidity			
Once	159	10.53	10.51 [9.42-11.71]
Twice	420	27.81	27.22 [25.565-28.95]
Three or more times	931	61.66	62.27 [60.34-64.16]
Partner HIV status			
HIV positive	337	45.54	45.45 [42.46-48.48]
HIV negative	208	28.11	29.66 [27.03-32.43]
Don't know his/their status	189	25.54	24.26 [21.73-26.97]
Don't have a sexual partner	6	0.81	0.63 [0.35-1.16]
Missing	802	802(52.01)	-
ART regimen type			
DTG-based regimen	861	58.89	59.18 [57.00-61.31]
EFV-based regimen	548	37.41	37.17 [35.05-39.22]
Second line regimen	54	3.69	3.71 [2.95-4.66]
Missing	80	5.2	-
Multiple sexual partners			
More than one sexual	40	4.90	4.61 [3.56-5.94]
One sexual partner	776	95.10	95.39 [94.06-96.44]
Missing	726	47.08	-
Syphilis status n (%)			
Positive	37	2.40	2.02 [1.57-2.59]
Negative	646	41.89	38.47 [36.00-40.00]
Missing	859	55.71	59.51 [56.94-62.04]
Trimester at booking			
First trimester	445	33.81	33.01 [31.02-35.06]
Second trimester	753	57.22	57.92 [55.74-60.08]
Third trimester	118	8.97	9.07 [7.85-10.44]

ART= Antiretroviral Therapy; CI= Confidence interval; DTG= Dolutegravir; EFV = Efavirenz; SD= Standard Deviation
IQR= Interquartile Range

3.3 VL Suppression

Among the 1,542 PWLHIV included in the analysis, 65.89% (95% CI: 63% to 68%) were virally suppressed (≤ 50 copies/mL) (see Table 3). Among those aged 15-24, 55.01% achieved VL suppression, the lowest among age groups, while 44.99% were non-suppressed. According to the racial category, 67.72% of Black Africans were virally suppressed, with 32.28% non-suppressed. Geographically, Gauteng achieved the highest VL suppression at 76.44%, with 23.56% non-suppressed. Mpumalanga had the lowest VL suppression at 46.04%, with 53.96% of the cases non-suppressed.

Regarding education, 66.51% of those with no/primary education achieved VL suppression, while 33.49% did not. Concerning partners age, only 55.99% of PWLHIV with partners aged 16-24 achieved VL suppression, compared to 47.01% who were non-suppressed, marking this group the lowest in the category. Regarding the relationship with the baby's father, Married PWLHIV achieved VL suppression of 72.81%, while 27.19% achieved none. According to the trimester at booking, among PWLHIV who booked in the first trimester, VL suppression was achieved by 70.95% while 29.05% did not achieve any. For those who booked in the third trimester, 52.40% achieved VL suppression while 47.60% did not. In terms of ART regimen, PWLHIV on DTG-based regimens achieved the highest VL suppression, with 72.55% virally suppressed compared to 27.45% who were non-suppressed.

Regarding parity, 69.47% of individuals with two children achieved VL suppression, in contrast to 30.53% who were non-suppressed. For gravidity, 67.20% of those who had been pregnant once achieved VL suppression, while 32.80% remained non-suppressed. When considering partners' HIV status, 68.64% of individuals with HIV-positive partners achieved VL suppression, compared to 31.36% who were non-suppressed. Among those who tested positive for syphilis, 70.53% achieved VL suppression, while 29.47% were non-suppressed. Overall, the findings indicate significant differences in VL suppression across various categories, underscoring the impact of these factors on treatment outcomes.

Table 3: Prevalence of VL suppression (<50 copies/mL) by key covariates among PWLHIV on ART at 1st ANC visit, N=1542

Covariate	Category	Total	VL suppression		Non-suppressed VL		P-value
			n (%)	95% CI	n (%)	95% CI	
Overall	VL suppression	1542	1016 (65.89)	0.63-0.68	526 (34.11)	-	
Age group (years)	15 – 24	244	133 (55.01)	49.61-60.30	111 (44.99)	39.70-50.39	0.0000
	25-34	853	590 (70.55)	68.07-72.92	263 (29.45)	27.08-31.93	
	35-49	445	293 (68.81)	65.18-72.22	152 (31.19)	27.78-34.82	
Race	African	1488	984 (67.72)	65.83-69.56	504 (32.28)	30.44-34.17	0.8916
	Other races	49	30 (67.04)	56.60-76.03	19 (32.96)	23.97-43.40	
Province	Eastern Cape	246	151 (61.38)	52.52-66.93	95 (38.62)	33.07-44.48	0.0000
	Free State	136	91 (66.91)	61.53-71.88	45 (33.09)	28.12-38.47	
	Gauteng	225	172 (76.44)	72.68-79.83	53 (23.56)	20.17-27.32	
	Kwazulu-Natal	466	327 (70.17)	66.34-73.74	139 (29.83)	26.26-33.66	
	Limpopo	88	56 (63.64)	55.09-71.40	32 (36.36)	28.60-44.91	
	Mpumalanga	139	64 (46.04)	39.20-53.03	75 (53.96)	46.97-60.80	
	Northern Cape	34	19 (55.88)	41.41-69.42	15 (44.12)	30.58-58.59	
	North West	104	61 (58.65)	51.57-65.40	43 (41.35)	36.60-48.43	
Education Level	Western Cape	104	75 (72.12)	66.14-77.40	29 (27.88)	22.60-33.86	0.6122
	None/Primary	183	114 (66.51)	60.98-71.63	69 (33.49)	28.37-39.02	
	Secondary	1160	757 (66.94)	64.79-69.03	403 (33.06)	30.97-35.21	
Partners age	Tertiary	179	126(69.77)	64.03-74.96	53(30.23)	25.04-35.97	0.0007
	16-24 years	72	40 (52.99)	44.26-61.53	32 (47.01)	38.47-55.74	
	25-34 years	577	379 (66.85)	63.66-69.89	198 (33.15)	30.11-36.34	
Relationship with the father	35-74 years	773	522 (70.16)	67.55-72.65	251 (29.84)	27.35-32.45	0.0321
	Married	224	156 (72.81)	68.28-76.90	68 (27.19)	23.10-31.72	
	Living together/co-habiting	488	292 (67.82)	28.93-35.61	156 (32.18)	28.93-35.61	
	Not living together but in a relationship	817	536 (66.21)	63.52-68.79	281 (33.79)	31.21-36.48	
Trimester at booking	No relationship	39	21 (57.49)	45.10-69.00	18 (42.51)	31.00-54.90	0.0000
	First	445	310 (70.95)	67.40-74.26	135 (29.05)	25.74-32.60	
	Second	753	497 (67.43)	64.60-70.14	256 (32.57)	29.86-35.40	
ART regimen type	Third	118	57(52.40)	44.90-59.80	61 (47.60)	40.20-55.10	0.0000
	DTG based	861	612 (72.55)	70.10-74.88	249 (27.45)	25.12-29.90	
	EFV based	547	336 (63.14)	59.78-66.39	211 (36.86)	33.61-40.22	
Parity	Second line	54	22 (46.11)	36.08-56.47	32 (53.89)	43.53-63.92	0.5531
	None	216	138 (65.24)	60.12-70.03	78 (34.76)	29.97-39.88	
	One	490	323 (67.11)	63.57-70.47	167 (32.89)	29.53-36.43	
	Two	460	314 (69.47)	66.21-72.54	146 (30.53)	27.46-33.79	
Gravidity	Three or more	363	233 (67.57)	63.57-71.32	130 (32.43)	28.68-36.43	0.6838
	Once	159	103 (67.20)	60.97-72.87	56 (32.80)	27.13-39.03	
	Twice	420	279 (66.61)	62.66-70.35	141 (33.39)	29.65-37.34	
Partner's HIV status	Three or more times	931	618 (68.52)	66.17-70.78	313 (31.48)	29.22-33.83	0.8376
	HIV positive	337	226 (68.64)	64.32-72.66	111 (31.36)	27.34-35.68	
	HIV negative	208	140 (68.86)	63.45-73.79	68 (31.14)	26.21-36.55	
	Other	991	646 (66.97)	64.69-69.17	345 (33.03)	30.83-35.31	
		6	4 (69.84)	37.90-89.78	2 (30.16)	10.22-62.10	

	Don't have a sexual partner						
Syphilis results	Positive	37	25 (70.53)	56.58-81.47	12 (29.47)	18.53-43.42	0.3848
	Negative	646	438 (69.08)	66.24-71.77	208 (30.92)	28.23-33.76	
	Missing	859	553 (66.61)	64.16-68.98	306 (33.39)	31.02-35.84	

ART= Antiretroviral Therapy; CI= Confidence interval; DTG- = Dolutegravir; EFV = Efavirenz

3.4 Factors Associated with Unsuppressed

In the univariable analysis, (see Table 4) PWLHIV aged 15 to 24 years had significantly higher odds of unsuppressed VL (OR 1.96, 95% CI: 1.52-2.52, $p < 0.001$) compared to those aged 25 to 34 years. The multivariable logistic regression analysis revealed that age 15 to 24 years was independently associated with higher odds of unsuppressed VL compared to those in the 25 to 34 years age group, with an adjusted Odds Ratio (aOR) 1.75 (95% CI: 1.25-2.45, $p = 0.001$) (see Table 4). In contrast, PWLHIV in the 35 to 49 age group did not show a significant association compared to those in the 25 to 34 age group, with an aOR of 1.18 (95% CI: 0.90-1.55, $p = 0.221$).

Based on the univariable analysis, women who booked ANC in the third trimester also showed higher odds of unsuppressed VL (OR 2.22 95% CI: 1.57-3.13, $p < 0.001$). In the multivariable model, the analysis revealed that booking ANC in the third trimester was independently associated with higher odds of unsuppressed VL than booking in the first trimester, with an aOR of 1.96 (95% CI: 1.33-2.88, $p < 0.001$). Booking in the second trimester did not significantly affect unsuppressed VL compared to booking in the first trimester, with an aOR of 1.21 (95% CI: 0.95-1.55, $p = 0.115$).

Regarding the relationship with the baby's father, women who were not married to the father did not show a significant association with unsuppressed VL, with an aOR of 1.00 (95% CI: 0.80-1.25, $p = 0.991$). This indicates no difference with those who were married. In terms of education level, no significant associations were identified between education level and unsuppressed VL. Specifically, individuals with secondary or tertiary education had aORs of 0.89 (95% CI: 0.64-1.22, $p = 0.457$) and 0.83 (95% CI: 0.53-1.30, $p = 0.408$) respectively, compared to those with no education or only primary education. Province was also significantly associated with unsuppressed VL in the univariable and multivariable models. Among the provinces, six provinces were independently associated with unsuppressed VL. Mpumalanga had the highest odds of unsuppressed VL compared to Gauteng, with an aOR of 4.31 (95% CI: 2.78-6.68, $p < 0.001$). In contrast, the Western Cape (aOR=1.33, 95% CI: 0.87-2.01, $p = 0.133$)

and the Northern Cape (aOR=1.40, 95% CI: 0.61-3.20, p=0.429) showed no significant association.

PWLHIV with partners aged 16 to 24 years did not show a significant association with unsuppressed VL, with an aOR of 0.95 (95% CI: 0.59-1.55, p=0.845) compared to those with partners aged 25 to 34 years. Partners aged 35 and older also did not show a significant association, with an aOR of 0.82 (95% CI: 0.63-1.06, p=0.129), compared to the 25 to 34 age group. For both the univariable and multivariable models, the ART regimen was significantly associated with unsuppressed VL. PWLHIV on EFV-based regimens had higher odds of unsuppressed VL, with an aOR of 1.68 (95% CI: 1.34-2.11, p<0.001) compared to those on DTG-based regimens. Those on second-line ART regimens exhibited an even higher aOR of 3.13 (95% CI: 1.83-5.34, p<0.001) compared to DTG-based regimens.

Table 4: Factors associated with unsuppressed VL (>49 copies/mL) among PWLHIV on ART at 1st ANC visit

Variable	Categories	Univariable (N=1542)		Multivariable (N=1152)	
		OR [95% CI]	P-value	aOR [95% CI]	P-value
Age group (years)	15-24	1.96 [1.52-2.52]	<0.001	1.75 [1.25-2.45]	0.001
	25-34	1.00	-	1.00	-
	35-49	1.09 [0.89-1.33]	0.428	1.18 [0.90-1.55]	0.221
Race	African	1.00	-	-	-
	Other races	1.03 [0.66-1.62]	0.892	-	-
Trimester at booking	First	1.00	-	1.00	-
	Second	1.18 [0.95-1.47]	0.137	1.21 [0.95-1.55]	0.115
	Third	2.22 [1.57-3.13]	<0.001	1.96 [1.33-2.88]	<0.001
Relationship with the father	Married	1.00	-	-	-
	Other	1.18 [0.99-1.41]	0.058	1.00 [0.80-1.25]	0.991
Sex under the influence of drugs or alcohol	Yes	1.00	-	-	-
	No	0.83 [0.50-1.37]	0.456	-	-
	Missing	0.84 [0.51-1.38]	0.484	-	-
Syphilis status	Positive	1.00	-	-	-
	Negative	1.07 [0.58-1.96]	0.823	-	-
	Missing	1.20 [0.65-2.23]	0.563	-	-
Education level	None/Primary	1.00	-	1.00	-
	Secondary	0.98 [0.76-1.27]	0.883	0.89 [0.64-1.22]	0.457
	Tertiary	0.86 [0.61-1.22]	0.402	0.83 [0.53-1.30]	0.408
Gravidity	Once/Twice	1.00	-	-	-
	Three or more times	0.92 [0.77-1.11]	0.390	-	-
Parity	None	1.00	-	-	-
	One/Two	0.87 [0.69-1.11]	0.269	-	-
	Three or more times	0.90 [0.68-1.19]	0.467	-	-
Partners' HIV status	HIV positive	1.00	-	-	-
	HIV negative	0.99 [0.73-1.34]	0.949	-	-
	Other	1.08 [0.87-1.35]	0.496	-	-
	Don't have a sexual partner	0.95 [0.26-3.63]	0.935	-	-
Province	Gauteng	1.00	-	1.00	-
	Eastern Cape	2.04 [1.49-2.79]	<0.001	2.07 [1.40-3.06]	<0.001
	Free State	1.60 [1.18-2.18]	0.003	1.49 [1.03-2.16]	0.034
	KwaZulu-Natal	1.38 [1.06-1.80]	0.018	1.57 [1.10-2.23]	0.013
	Limpopo	1.85 [1.23-2.79]	0.003	2.11 [1.22-3.65]	0.008
	Mpumalanga	3.80 [2.70-5.36]	<0.001	4.31 [2.78-6.68]	<0.001
	Northern Cape	2.56 [1.38-4.75]	0.003	1.40 [0.61-3.20]	0.429
	North West	2.29 [1.38-4.75]	0.003	3.39 [2.16-5.32]	<0.001
	Western Cape	1.25 [0.89-1.77]	0.196	1.33 [0.87-2.01]	0.133
Multiple sexual partners	More than one sexual partner	1.00	-	-	-
	One sexual partner	1.07 [0.63-1.82]	0.813	-	-
	Missing	1.01 [0.59-1.71]	0.973	-	-
Partner age (years)	16-24	1.79 [1.23-2.59]	0.002	0.95 [0.59-1.55]	0.845
	25-34	1.00	-	1.00	-
	35-74	0.86 [0.71-1.04]	0.1171	0.82 [0.63-1.06]	0.129
ART regimen type	DTG-based	1.00	-	-	-
	EFV-based	1.54 [1.28-1.86]	<0.001	1.68 [1.34-2.11]	<0.001
	Second line	3.09 [1.99-4.79]	<0.001	3.13 [1.83-5.34]	<0.001

ART= Antiretroviral Therapy; CI= Confidence interval; DTG= Dolutegravir; EFV = Efavirenz;

OR= Odds ratio; SD= Standard deviation; aOR= adjusted Odds ratio

3.5 Post-Hoc Power Analysis

A post hoc power analysis was performed using the one-sample proportion test to determine the statistical power for the realized sample size. With a sample size of 1,542, an alpha level of 0.05, and a null hypothesis proportion of 0.63, the power to detect an alternative proportion of 0.68 was calculated. The estimated power was 0.9854.

CHAPTER FOUR: DISCUSSION

This study aimed to estimate the prevalence of VL suppression among PWLHIV who were on ART before pregnancy and were attending their first ANC visit in South African public health facilities during the 2022 ANC survey period. Furthermore, the investigation examined factors associated with VL suppression among this group of PWLHIV. This chapter discusses the findings of the analysis and the implications of the findings on policy, practice, and research. Lastly, the chapter makes recommendations on how to improve viral suppression among pregnant women on ART before pregnancy.

4.1 Summary of Findings

The findings revealed that 65.89% of the 1,542 participants achieved VL suppression (<50 copies/mL). While this indicates that a majority of PWLHIV are achieving suppression, the rate reflects a decline from the 70.01% reported in 2017(45), suggesting a potential stagnation or setback in efforts to improve viral suppression over time. Our multivariable logistic regression indicated that young age, Province, trimester at booking, and ART regimen were independently associated with unsuppressed VL.

VL Suppression

Despite the majority of PWLHIV achieving VL suppression, the findings revealed that VL suppression among PWLHIV attending their first ANC visit and already on ART before pregnancy was lower than the 74.4% reported by Woldesenbet et al. (2022) for similar populations(19). This discrepancy could be partly attributed to the COVID-19 pandemic, which disrupted healthcare services between the 2019 and 2022 surveys. Under normal circumstances, we would have expected an improvement in VL suppression in 2022, particularly following the introduction of DTG to all PLHIV and PWLHIV in 2019, a more effective ART regimen. However, the disruptions caused by COVID-19 significantly impacted healthcare services(95). PWLHIV experienced reduced access to vital services like VL testing and ART monitoring(96). Concerns about contracting COVID-19, coupled with the stigma surrounding the virus, resulted in fewer clinic visits, which may have negatively affected ART adherence and VL suppression(97). Additionally, staff shortages in healthcare facilities due to COVID-19 infections further hindered the delivery of care(97). It would be interesting to see what post-COVID data would reveal, as most published studies concern themselves with data from before or during the COVID-19 pandemic. Notably, PWLHIV who were on ART at first ANC should represent the highest suppression levels among all pregnant women, highlighting systemic challenges in achieving optimal health outcomes.

For PWLHIV, this finding underscores the need for improved support systems, adherence strategies, and better pre-conception care for women of reproductive age living with HIV. To address the VL suppression challenge, several interventions have been implemented in South Africa and similar settings to support VL suppression among PWLHIV. One such initiative is MomConnect, a program that uses mobile technology to deliver maternal health information via SMS or WhatsApp. This service provides pregnant women and new mothers with important health messaging and access to a text-based helpdesk, offering essential support to improve health outcomes(98). However, their impact remains uneven. For example, MomConnect digital reach is limited in rural or digitally excluded communities. Furthermore, the program begins only after ANC booking, missing the opportunity for early intervention in the pre-pregnancy phase. Moreover, its effectiveness in ensuring viral suppression by delivery depends on timely engagement and adherence to the information provided. Given these constraints, scaling digital health interventions and peer-led models must be matched with health system strengthening for example, routine follow-up systems, more frequent VL monitoring, decentralised ART delivery, and adolescent-friendly services, particularly in provinces with weaker suppression outcomes.

Another intervention is the electronic gatekeeping system within the National Health Laboratory Service (NHLS). This system optimises healthcare resources by reducing unnecessary repeat testing and increasing the frequency of HIV VL testing for pregnant women, thereby improving virological surveillance and treatment outcomes(99). While this system has the potential to improve virological monitoring during pregnancy, its implementation varies across provinces and facilities due to resource constraints, staff shortages, and system inefficiencies. In theory, all public ANC clinics in South Africa are expected to offer routine VL testing to PWLHIV, with key time points including the first ANC booking, every six months during pregnancy, and at delivery or immediately postpartum. However, in practice, VL testing is often delayed or missed especially for women who book late for ANC or in facilities with limited laboratory infrastructure. Furthermore, results are not always communicated promptly to either healthcare providers or the women themselves. This delay undermines timely clinical decision-making and may result in missed opportunities for interventions, particularly for women with unsuppressed VL.

To maximise the effectiveness of the NHLS system, timely feedback loops must be strengthened, ensuring that VL results are consistently available to clinicians and clearly

communicated to women. This calls for improved data systems, healthcare worker training, and accountability mechanisms that ensure VL testing guidelines are followed uniformly across provinces. Without these, the benefits of NHLS's electronic gatekeeping system may remain unrealised for many PWLHIV.

Additionally, the Mentor Mothers Programme is a community-based intervention where experienced mothers provide peer support, education and encouragement to pregnant women and new mothers living with HIV. This program has been shown to improve ART adherence and promote VL suppression by offering continuous guidance and support(100). It is important to know that this intervention is available to help women once they start ANC help to ensure better ART adherence and VL suppression. The Mentor Mothers Programme, while effective in offering peer support, is not yet scaled up nationwide. The success of the programme depends on community buy-in, sustained funding, and integration into existing primary care services, which remains inconsistent. These limitations suggest that complementary community-level interventions, such as pre-conception counseling and integration with youth-focused services, are needed to fill existing gaps.

Furthermore, the use of injectable ART regimens could be another possible intervention in the near future. There have been some studies and discussions around the use of injectable ART among pregnant women, although it is still an emerging area of research(101). Injectable ART regimens have emerged as a promising intervention in the fight against HIV, offering a safe, convenient and effective alternative to daily oral medications(102,103). Given the potential for improved adherence, exploring the use of injectable ART among pregnant women could be the key to enhancing viral suppression among PWLHIV. Healthcare providers should strengthen engagement with PWLHIV and offer personalized counseling and resources. Policymakers must prioritize scaling up the above-mentioned successful interventions to overcome barriers to effective HIV care and ensure that the 95-95-95 VL suppression target is met by 2025.

Age

Another key finding was the lower VL suppression among younger women aged 15-24, notably less than that of older women. These results are consistent with existing research that links younger

age to unsuppressed VLs. Previous studies have identified younger age as a risk factor for poorer treatment outcomes, suggesting that younger women may encounter greater challenges

in achieving effective HIV management, potentially due to adherence issues, alcohol use, smoking, nondisclosure to sexual partners, stigma, and barriers to accessing healthcare(15,40,54).

For PWLHIV, the implications are clear: younger women require tailored support and interventions to improve their treatment adherence and health outcomes. Several studies and programs have been designed to improve adherence and retention in care for young women living with HIV. For instance, Okonji et al.(2020) emphasizes four primary treatment modalities that can improve ART adherence and retention among young people: support groups, individual counseling, treatment supporters, and family-centered services(104).

One notable program intervention is Mentor Mother that employs women living with HIV as community health workers known as mentor mothers to provide peer support to young mothers living with HIV(100). These Mentor Mothers are parents and offer a safe space for young mothers to gain support and make friends, which can help improve adherence to treatment and retention in care(100). Another approach is the Enable Programme by One-to-One Africa. This program involves door-to-door health interventions by trained mentor mothers, who provide access to clinics, monitor health, and offer support and advice(105). The Enable Programme has achieved a near-zero MTCT, demonstrating its effectiveness(105).

Healthcare providers should therefore consider implementing youth-friendly services and creating supportive environments that encourage open communication and trust. For policymakers, investing in targeted programs for younger populations, such as mentorship initiatives or peer support groups, could effectively address the specific barriers faced by young PWLHIV. Research indicates that such interventions can improve adherence and health outcomes, making them crucial elements of an effective response to the challenges highlighted by this finding.

Trimester at booking

Booking for ANC in the third trimester was identified as a significant predictor of unsuppressed VL. This observation is consistent with prior research findings that highlight the detrimental impact of late ANC initiation on VL suppression(24). Early ANC booking is crucial for improving treatment outcomes, as it allows more time for effective VL management(39).

In South Africa, several structural and individual-level barriers contribute to delayed ANC initiation. These include unplanned pregnancies, educational level, insufficient knowledge about the importance of early ANC, fear of stigma, marital status, cultural beliefs, economic barriers, and health system challenges such as long wait times and negative attitudes from healthcare providers(106,107). In many communities, younger women may delay ANC due to fear of judgment, lack of partner support, or limited reproductive health literacy. Despite national ANC guidelines recommending that pregnant women attend their first ANC visit before 12 weeks gestation, many women only book well into their second or third trimester, with significant implications for both maternal and child health outcomes.

To address these challenges, targeted and context-specific interventions are urgently needed. These could include: Community-based education campaigns that focus on increasing awareness about the benefits of early ANC, particularly in rural and high-burden HIV areas. These campaigns should also directly address stigma and misinformation. Integration of HIV and reproductive health services at the community level, including family planning, to ensure women of reproductive age are engaged in care even before pregnancy. Use of community health workers and Mentor Mothers to trace and support women who miss early ANC appointments, particularly among adolescents and young women. These peer-led interventions can offer non-judgmental, confidential support. Incentivised care-seeking, such as conditional cash transfers or transport vouchers, to reduce economic barriers to early booking. Training healthcare workers to provide youth-friendly, respectful, and non-stigmatizing care, which may encourage earlier engagement with the health system. Mobile health tools, such as expanded use of MomConnect, could be adapted to send pre-conception and early pregnancy reminders, encouraging women to attend ANC as soon as pregnancy is confirmed. Ultimately, a multi-pronged approach addressing individual, community, and health system barriers is essential to promote early ANC booking and improve VL suppression outcomes among PWLHIV in South Africa.

Geographical location

The results show notable regional disparities in VL suppression among PWLHIV across different provinces in South Africa. Gauteng achieved the highest VL suppression in this population, while Mpumalanga had the lowest VL suppression. In contrast, the Western Cape and the Northern Cape showed no significant association with unsuppressed VL. These findings indicate substantial regional differences in VL suppression among PWLHIV,

suggesting that factors such as access to healthcare services, adherence to ART, and overall healthcare infrastructure may vary significantly across provinces.

The results align with previous studies that have highlighted regional disparities in VL suppression(9). For PWLHIV who were on ART before pregnancy, these disparities mean that those residing in provinces like Mpumalanga are at a higher risk of health complications and vertical transmission of HIV. This underscores the importance of addressing barriers to care and ensuring consistent access to ART.

Healthcare providers in regions with lower VL suppression may need to implement more robust strategies to improve ART adherence and retention in care. This could involve enhancing patient education, providing more comprehensive support services, and addressing specific barriers to accessing care. For the Department of Health and policymakers, these findings highlight the need for a regionalized approach to HIV care. Policies and programs should be tailored to specific needs of each province.

ART regimen

PWLHIV on a DTG-based regimen exhibited the highest VL suppression compared to those on EFV and second-line regimens. 59.18% of PWLHIV were on DTG-based regimens, with 72.55% achieving viral suppression. This finding is consistent with other studies that highlight the advantages of DTG to all populations including rapid VL suppression, cost-effectiveness, increased tolerability, and reduced drug resistance(108). The evidence supports prioritizing DTG in treatment protocols, especially considering that individuals on second-line regimens typically have a history of first-line treatment failure often linked to adherence challenges(108,109).

The UNAIDS aims for at least 95% of individuals to be on ART and to achieve viral suppression by 2025. In 2022, 98.8% of PWLHIV in South Africa were on ART(110). While this study demonstrates promising outcomes, achieving VL suppression of 95% necessitates ongoing efforts to enhance adherence support and optimize DTG regimen management.

Education and marital status

In contrast to some studies that identified education level and marital status as a significant determinant of VL suppression(17,30), this study did not find a notable association between these variables and VL suppression. This discrepancy suggests that in the context of South

African public health facilities, other factors such as access to healthcare, ART regimen type and provincial healthcare disparities may have a more pronounced effect on VL outcomes for women who have been on ART for an extended period. It is important to note that factors influencing VL suppression could differ for pregnant women starting ART during pregnancy. Other factors such as gestational age and ART initiation timing may also play a more significant role in VL suppression among PWLHIV.

Overall, the study provides valuable insights into factors affecting VL suppression among PWLHIV. The findings emphasize the importance of public health strategies to encourage early ANC booking, optimize ART regimens, and improve the management of young women.

In addition to the findings of this study, it is important to acknowledge that other factors have been shown to influence VL suppression among PWLHIV. The 2019 and 2022 South African National Antenatal HIV Sentinel Survey reports identified province, partner's age, parity, and ART regimen as significant factors associated with VL suppression(110). These findings support the inclusion of these variables in the analysis and highlight their continued relevance in understanding virological outcomes. For instance, regional disparities in healthcare access and service delivery likely contribute to provincial differences in VL suppression. Partner dynamics, including partner age, may influence disclosure, adherence, and emotional support, while parity may reflect cumulative healthcare engagement and ART experience. These ANC surveys provide important contextual evidence reinforcing the need for a multifactorial approach to improving maternal HIV outcomes, one that considers both clinical and social determinants of health.

4.2 Strength and Limitations

Strengths of this study include its use of a large dataset, which allowed for the analysis of VL suppression among PWLHIV across all provinces of South Africa. The study provides valuable insights into the key determinants of viral load suppression, including ART regimen types, age, and the timing of ANC booking. This broad dataset enhances the study's relevance for public health strategies and identifies actionable areas for improving maternal health outcomes. However, there are several limitations to consider. This study utilized secondary data, which inherently limits the research to the data collected in the primary survey and what is available. Consequently, some variables had missing data exceeding 5%. While the missing data were incorporated into the analytical model, this may impact the accuracy and validity of the results. Another potential limitation of this study is the over-representation of participants from

Gauteng and KwaZulu-Natal, which may limit the ability to generalise the findings to the broader national population. Since these provinces represent a large portion of the sample, the results may not fully reflect the demographic and geographic diversity of PWLHIV in South Africa.

Additionally, the reliance on existing datasets means that the original data collection methods, including their potential biases and limitations, are not under the control of this study. This could lead to confounding factors that may affect the findings. Furthermore, the inability to explore variables beyond those in the dataset limits the study's scope and may hinder a comprehensive understanding of the research question.

The study also faced limitations related to its cross-sectional design, capturing only a snapshot in time, which makes it challenging to establish causal relationships between variables. This design restricts the ability to observe changes over time, which may be crucial for understanding the relationships' dynamics. Moreover, the survey did not include pregnant women younger than 15 years or older than 49 years. The study was also restricted to public facilities, which may limit the generalisability of the findings to the overall population, particularly among high-income groups and certain racial groups.

4.3 Conclusion and Recommendations

This study highlights that while VL suppression among PWLHIV who were on ART before becoming pregnant in South Africa is a critical public health goal, the current VL suppression of 65.89% indicates room for improvement. Key determinants of VL suppression include age, trimester at booking, province, and ART regimen type. Specifically, younger age and late ANC booking were associated with higher odds of unsuppressed VL. DTG-based regimens were more effective compared to EFV-based and second-line regimens. Education level did not significantly correlate with VL suppression, suggesting that other factors may be more critical in this context.

To improve VL suppression among PWLHIV, public health strategies should focus on optimizing ART regimens and enhancing VL monitoring protocols. The findings support the need to prioritize the rollout and consistent availability of DTG-based regimens for eligible women, given their superior virological outcomes compared to EFV-based and second-line regimens. Clinical guidelines should also encourage regular treatment reviews to identify and support PWLHIV who may benefit from transitioning to DTG-based therapy, particularly those on older or second-line regimens.

Strengthening the implementation of national VL monitoring guidelines is critical. VL testing should be consistently conducted at the first ANC visit for women already on ART, and six months after ART initiation for those newly diagnosed during pregnancy. For high-risk subgroups such as younger women, late ANC bookers, and those on second-line treatment enhanced VL monitoring at shorter intervals may be beneficial. Improving the timeliness and communication of VL results to both healthcare providers and patients is essential, and should be supported by robust digital reporting systems and follow-up mechanisms.

Policy development should support the integration of patient tracking systems that flag unsuppressed VL results and facilitate rapid clinical interventions, including adherence counselling or ART regimen adjustments. Community-based initiatives that encourage early ANC booking, particularly among younger women, could also contribute to better maternal and infant health outcomes.

Future research should aim to include more geographically diverse samples to enhance generalizability, and explore additional factors that influence VL suppression. Qualitative investigations could provide valuable insights into the experiences of PWLHIV who remain unsuppressed despite being on ART, while operational studies could assess gaps in the implementation of VL monitoring and regimen switching in real-world settings.

REFERENCES

1. UNAIDS, 2023. HIV and AIDS Estimates [Internet]. Available from: <https://www.unaids.org/en/regionscountries/countries/southafrica>.
2. Clouse K, Malope-Kgokong B, Bor J, Nattey C, Mudau M, Maskew M. The South African National HIV Pregnancy Cohort: evaluating continuity of care among women living with HIV. BMC Public Health [Internet]. 2020 Dec [cited 2025 Jun 10];20(1):1662. Available from: <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09679-1>.
3. Adverse perinatal outcomes attributable to HIV in sub-Saharan Africa from 1990 to 2020: Systematic review and meta-analyses | Communications Medicine [Internet]. [cited 2024 Jul 23]. Available from: <https://www.nature.com/articles/s43856-023-00331-8>.
4. South Africa [Internet]. [cited 2024 May 24]. Available from: <https://www.unaids.org/en/regionscountries/countries/southafrica>.
5. Dimitri C. How South African women's HIV status impacts the obstetric care they receive. In. Available from: <https://sph.brown.edu/news/2024-11-07/south-africa-hiv-obstetric-care>.
6. Hlongwane TM, Bozkurt B, Barreix MC, Pattinson R, Gülmezoglu M, Vannevel V, et al. Implementing antenatal care recommendations, South Africa. Bull World Health Organ [Internet]. 2021 Mar 3 [cited 2024 Jun 6];99(3):220. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7941100/>.
7. Ebonwu, J, Mumbauer, A, Uys, M, Wainberg, ML & Medina-Marino, A 2018, "Determinants of late antenatal care presentation in rural and peri-urban communities in South Africa: A cross-sectional study," *PLoS ONE*, 13(3): e0191903.
8. UNICEF DATA [Internet]. [cited 2024 Jun 6]. Antenatal care. Available from: <https://data.unicef.org/topic/maternal-health/antenatal-care/>.
9. Woldeesenbet S, Cheyip M, Lombard C, Manda S, Ayalew K, Kufa T, et al. Progress towards the UNAIDS 95-95-95 targets among pregnant women in South Africa: Results from the 2017 and 2019 national Antenatal HIV Sentinel Surveys. Torpey K, editor. PLOS ONE [Internet]. 2022 Jul 21 [cited 2024 Oct 16];17(7): e0271564. Available from: <https://dx.plos.org/10.1371/journal.pone.0271564>.
10. SDN-CC-10-01-GUIDELINE-eng-Antenatal-Health-Care-Services.pdf [Internet]. [cited 2024 Jun 6]. Available from: <https://platform.who.int/docs/default-source/mca-documents/policy-documents/guideline/SDN-CC-10-01-GUIDELINE-eng-Antenatal-Health-Care-Services.pdf>.
11. 2023 Vertical Transmission Prevention Guideline 23102023 signed WEB (5).pdf [Internet]. [cited 2024 Oct 29]. Available from: <https://knowledgehub.health.gov.za/system/files/elibdownloads/2023-10/2023%20Vertical%20Transmission%20Prevention%20Guideline%2023102023%20signed%20WEB%20%285%29.pdf>.
12. South African National Department of Health 2023b, *Guideline for Vertical Transmission Prevention of Communicable Infections*, October 31, 2024, <https://knowledgehub.health.gov.za/system/files/elibdownloads/2023-10/2023%20Vertical%20Transmission%20Prevention%20Guideline%2023102023%20signed%20WEB%20%285%29.pdf>. 12. Updated recommendations on HIV prevention, infant

- diagnosis, antiretroviral initiation and monitoring [Internet]. [cited 2024 Jun 4]. Available from: <https://www.who.int/publications-detail-redirect/9789240022232>.
13. Updated recommendations on HIV prevention, infant diagnosis, antiretroviral initiation and monitoring [Internet]. [cited 2024 Jun 4]. Available from: <https://www.who.int/publications-detail-redirect/9789240022232>.
 14. HIV - Global [Internet]. [cited 2024 Jun 4]. Available from: <https://www.who.int/health-topics/hiv-aids>.
 15. Ngandu NK, Lombard CJ, Mbira TE, Puren A, Waitt C, Prendergast AJ, et al. HIV viral load non-suppression and associated factors among pregnant and postpartum women in rural northeastern South Africa: a cross-sectional survey. *BMJ Open* [Internet]. 2022 Mar [cited 2024 Nov 1];12(3): e058347. Available from: <https://bmjopen.bmj.com/lookup/doi/10.1136/bmjopen-2021-058347>.
 16. Ntombela NP, Kharsany ABM, Soogun A, Yende-Zuma N, Baxter C, Kohler HP, et al. Viral suppression among pregnant adolescents and women living with HIV in rural KwaZulu-Natal, South Africa: a cross-sectional study to assess progress towards UNAIDS indicators and Implications for HIV Epidemic Control. *Reprod Health* [Internet]. 2022 Dec [cited 2024 May 30];19(1):116. Available from: <https://reproductive-health-journal.biomedcentral.com/articles/10.1186/s12978-022-01419-5>.
 17. UNAIDS. Global HIV & AIDS statistics — Fact sheet [Internet]. 2024. Available from: <https://www.unaids.org/en/resources/fact-sheet>.
 18. UNAIDS. UNAIDS. Global AIDS Update 2020: Seizing the moment. [Internet]. 2020. Available from: https://www.unaids.org/sites/default/files/media_asset/2020_global-aids-report_en.pdf.
 19. Woldesenbet S, Kufa T, Manda S, Ayalew K, Lombard C, Cheyip M, et al. Association between viral suppression during the third trimester of pregnancy and unintended pregnancy among women on antiretroviral therapy: Results from the 2019 antenatal HIV Sentinel Survey, South Africa. Kalk EK, editor. *PLOS ONE* [Internet]. 2022 Mar 17 [cited 2025 Jun 9];17(3): e0265124. Available from: <https://dx.plos.org/10.1371/journal.pone.0265124>.
 20. Wessels J, Sherman G, Bamford L, Makua M, Ntloana M, Nuttall J, et al. The updated South African National Guideline for the Prevention of Mother to Child Transmission of Communicable Infections (2019). *South Afr J HIV Med* [Internet]. 2020 Jul 8 [cited 2025 Jun 11];21(1). Available from: <http://www.sajhivmed.org.za/index.php/HIVMED/article/view/1079>.
 21. Unfinished business: only the urgent and accelerated delivery of HIV services will keep the promise of ending AIDS in children by 2030 [Internet]. [cited 2025 Jan 20]. Available from: https://www.unaids.org/en/resources/presscentre/pressreleaseandstatementarchive/2024/july/20240722_transforming-vision-into-reality.
 22. Moyo F, Mazanderani AH, Murray T, Sherman GG, Kufa T. Achieving maternal viral load suppression for elimination of mother-to-child transmission of HIV in South Africa. *AIDS* [Internet]. 2021 Feb 2 [cited 2024 May 24];35(2):307–16. Available from: <https://journals.lww.com/10.1097/QAD.0000000000002733>.

23. Duri K, Munjoma PT, Mazhandu AJ, Marere T, Gomo E, Banhwa S, et al. Predictors and Timing to Viral Suppression in HIV-Infected Pregnant Women in the University of Zimbabwe Birth Cohort Study During the Era of Lifelong Antiretroviral Therapy (Option B+ Treatment Strategy). *Front Virol* [Internet]. 2022 Apr 6 [cited 2025 Jun 12]; 2:838234. Available from: <https://www.frontiersin.org/articles/10.3389/fviro.2022.838234/full>.
24. Woldesenbet SA, Kufa T, Barron P, Chirombo BC, Cheyip M, Ayalew K, et al. Viral suppression, and factors associated with failure to achieve viral suppression among pregnant women in South Africa. *AIDS* [Internet]. 2020 Mar 15 [cited 2025 Jun 9];34(4):589–97. Available from: <https://journals.lww.com/10.1097/QAD.0000000000002457>.
25. Kufa-Chakezha T, Nosipho S, Puren A. The 2022 Antenatal Care HIV Sentinel Surveillance: Key Findings [Internet]. Available from: https://www.nicd.ac.za/wp-content/uploads/2023/12/The-2022-ANCsurvey_Dec-2023_Finalresults_Share.pdf.
26. Myer L, Phillips T, McIntyre J, Hsiao N, Petro G, Zerbe A, et al. HIV viraemia and mother-to-child transmission risk after antiretroviral therapy initiation in pregnancy in Cape Town, South Africa. *HIV Med* [Internet]. 2017 Feb [cited 2024 May 27];18(2):80–8. Available from: <https://onlinelibrary.wiley.com/doi/10.1111/hiv.12397>.
27. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach, 2nd ed [Internet]. [cited 2024 May 29]. Available from: <https://www.who.int/publications-detail-redirect/9789241549684>.
28. Thea DM, Steketee RW, Pliner V, Bornschlegel K, Brown T, Orloff S, et al. The effect of maternal viral load on the risk of perinatal transmission of HIV-1: *AIDS* [Internet]. 1997 Mar [cited 2024 May 30];11(4):437–44. Available from: <http://journals.lww.com/00002030-199704000-00006>.
29. Kebede, B, Andargie, G & Gebeyehu, A 2013b, “Birth outcome and correlates of low birth weight and preterm delivery among infants born to HIV-infected women in public hospitals of Northwest Ethiopia,” *Health*, 05(07):25–34.
30. Concepcion T, Velloza J, Kemp CG, Bhat A, Bennett IM, Rao D, et al. Perinatal Depressive Symptoms and Viral Non-suppression Among a Prospective Cohort of Pregnant Women Living with HIV in Nigeria, Kenya, Uganda, and Tanzania. *AIDS Behav* [Internet]. 2023 Mar 1 [cited 2024 Jun 5];27(3):783–95. Available from: <https://link.springer.com/article/10.1007/s10461-022-03810-6>.
31. Fowler MG, Qin M, Fiscus SA, Currier JS, Flynn PM, Chipato T, et al. Benefits and Risks of Antiretroviral Therapy for Perinatal HIV Prevention. *N Engl J Med* [Internet]. 2016 Nov 3 [cited 2024 May 29];375(18):1726–37. Available from: <http://www.nejm.org/doi/10.1056/NEJMoa1511691>.
32. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, et al. Prevention of HIV-1 Infection with Early Antiretroviral Therapy. *N Engl J Med* [Internet]. 2011 Aug 11 [cited 2024 May 29];365(6):493–505. Available from: <http://www.nejm.org/doi/abs/10.1056/NEJMoa1105243>.
33. Mandelbrot L, Tubiana R, Le Chenadec J, Dollfus C, Faye A, Pannier E, et al. No Perinatal HIV-1 Transmission from Women with Effective Antiretroviral Therapy Starting

- Before Conception. Clin Infect Dis [Internet]. 2015 Jul 21 [cited 2024 May 29]; civ578. Available from: <https://academic.oup.com/cid/article-lookup/doi/10.1093/cid/civ578>.
34. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach, 2nd ed [Internet]. [cited 2024 May 29]. Available from: <https://www.who.int/publications-detail-redirect/9789241549684>.
 35. National Department of Health. National ART Clinical Guideline AR 4.5 20230713 Version 4 WEB.pdf [Internet]. 2023. Available from: <https://knowledgehub.health.gov.za/elibrary/2023-art-clinical-guidelines-management-hiv-adults-pregnancy-and-breastfeeding-adolescents>National ART Clinical Guideline AR 4.5 20230713 Version 4 WEB.pdf.
 36. Moorhouse M, Maartens G, Venter WDF, Moosa MY, Steegen K, Jamaloodien K, et al. Third-Line Antiretroviral Therapy Program in the South African Public Sector: Cohort Description and Virological Outcomes. JAIDS J Acquir Immune Defic Syndr [Internet]. 2019 Jan 1 [cited 2025 Jun 11];80(1):73–8. Available from: <https://journals.lww.com/00126334-201901010-00013>.
 37. Albrecht, S, Semrau, K, Kasonde, P, Sinkala, M, Kankasa, C, Vwalika, C, Aldrovandi, GM, Thea, DM & Kuhn, L 2005, “Predictors of Nonadherence to Single-Dose Nevirapine Therapy for the Prevention of Mother-to-Child HIV Transmission,” *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 41(1):114–118.
 38. Karcher, H, Kunz, A, Poggensee, G, Mbezi, P, Mugenyi, K & Harms, G 2006, “Outcome of Different Nevirapine Administration Strategies in Preventin g Mother-to-Child Transmission (PMTCT) Programs in Tanzania and Uganda,” *Journal of the International AIDS Society*, 8(1):12.
 39. Adeniyi OV, Obi CL, Goon DT, Iweriebor B, Selanto-Chairman N, Carty C, et al. Factors Associated with Peripartum Virologic Suppression in Eastern Cape Province, South Africa: A Retrospective Cross-Sectional Analysis. Clin Infect Dis [Internet]. 2021 Nov 16 [cited 2024 Oct 30];73(10):1750–8. Available from: <https://academic.oup.com/cid/article/73/10/1750/6157009>
 40. Mirkuzie, AH, Hinderaker, SG, Sisay, MM, Moland, KM & Mørkve, O 2011, “Current status of medication adherence and infant follow up in the prevention of mother to child HIV transmission programme in Addis Ababa: a cohort study,” *Journal of the International AIDS Society*, 14(1):50.
 41. Kirsten, I, Sewangi, J, Kunz, A, Dugange, F, Ziske, J, Jordan-Harder, B, Harms, G & Theuring, S 2011, “Adherence to Combination Prophylaxis for Prevention of Mother-to-Child-Transmission of HIV in Tanzania,” *PLoS ONE*, 6(6): e21020.
 42. Stringer EM. Coverage of Nevirapine-Based Services to Prevent Mother-to-Child HIV Transmission in 4 African Countries. JAMA [Internet]. 2010 Jul 21 [cited 2024 Aug 28];304(3):293. Available from: <http://jama.jamanetwork.com/article.aspx?doi=10.1001/jama.2010.990>.
 43. Chohan BH, Ronen K, Khasimwa B, Matemo D, Osborn L, Unger JA, et al. Food insecurity, drug resistance and non-disclosure are associated with virologic non-suppression among HIV pregnant women on antiretroviral treatment. Donnell D, editor.

- PLOS ONE [Internet]. 2021 Aug 18 [cited 2024 Aug 12];16(8): e0256249. Available from: <https://dx.plos.org/10.1371/journal.pone.0256249>.
44. Mabetha K, Soepnel L, Klingberg S, Mabena G, Motlathledi M, Norris SA, et al. Social Support during pregnancy: A phenomenological exploration of young women's experiences of support networks on pregnancy care and wellbeing in Soweto, South Africa [Internet]. 2022 [cited 2024 Aug 12]. Available from: <http://medrxiv.org/lookup/doi/10.1101/2022.04.03.22273162>.
 45. Gourlay, A, Birdthistle, I, Mburu, G, Iorpenda, K & Wringe, A 2013, "Barriers and facilitating factors to the uptake of antiretroviral drugs for prevention of mother-to-child transmission of HIV in sub-Saharan Africa: a systematic review," *Journal of the International AIDS Society*, 16(1).
 46. Theilgaard ZP, Katzenstein TL, Chiduo MG, Pahl C, Bygbjerg IC, Gerstoft J, et al. Addressing the fear and consequences of stigmatization - a necessary step towards making HAART accessible to women in Tanzania: a qualitative study. *AIDS Res Ther* [Internet]. 2011 [cited 2024 Nov 1];8(1):28. Available from: <http://aidsrestherapy.biomedcentral.com/articles/10.1186/1742-6405-8-28>.
 47. Burch LS, Smith CJ, Phillips AN, Johnson MA, Lampe FC. Socioeconomic status and response to antiretroviral therapy in high-income countries: a literature review. *AIDS* [Internet]. 2016 May 15 [cited 2024 Jun 7];30(8):1147–61. Available from: <https://journals.lww.com/00002030-201605150-00001>
 48. Peltzer K, Pengpid S. Socioeconomic Factors in Adherence to HIV Therapy in Low- and Middle-income Countries. *J Health Popul Nutr* [Internet]. 2013 Jun [cited 2024 Jun 7];31(2):150–70. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3702336/>.
 49. Washio Y, Browne FA, Ndirangu J, Kline TL, Wechsberg WM. Antiretroviral Therapy (ART) Adherence and Prenatal Alcohol Use among Women Who Are Pregnant with HIV in South Africa. *Int J Environ Res Public Health* [Internet]. 2021 Jul 13 [cited 2024 Jun 5];18(14):7446. Available from: <https://www.mdpi.com/1660-4601/18/14/7446>
 50. Kaswa R, De Villiers MR. The effect of substance uses on antiretroviral treatment adherence in primary health care. *South Afr Fam Pract* [Internet]. 2023 Mar 30 [cited 2024 Jun 6];65(1). Available from: <https://safpj.co.za/index.php/safpj/article/view/5660>.
 51. Denoeud-Ndam L, Fourcade C, Ogouyemi-Hounto A, Azon-Kouanou A, d'Almeida M, Azondékon A, et al. Predictive Factors of Plasma HIV Suppression during Pregnancy: A Prospective Cohort Study in Benin. *PLOS ONE* [Internet]. 2013 Mar 15 [cited 2024 Jun 5];8(3): e59446. Available from: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0059446>.
 52. Adeniyi OV, Ajayi AI, Ter Goon D, Owolabi EO, Eboh A, Lambert J. Factors affecting adherence to antiretroviral therapy among pregnant women in the Eastern Cape, South Africa. *BMC Infect Dis* [Internet]. 2018 Dec [cited 2024 Nov 5];18(1):175. Available from: <https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-018-3087-8>.
 53. Schrubbe LA, Stöckl H, Hatcher AM, Marston M, Kuchukhidze S, Calvert C. Prevalence and risk factors of unsuppressed viral load among pregnant and breastfeeding women in

- sub-Saharan Africa: analysis from population-based surveys. *AIDS Lond Engl*. 2023 Mar 15;37(4):659–69.
54. Watson-Jones, D, Balira, R, Ross, DA, Weiss, HA & Mabey, D 2012b, “Missed Opportunities: Poor Linkage into Ongoing Care for HIV-Positive Pregnant Women in Mwanza, Tanzania,” *PLoS ONE*, 7(7): e40091.
 55. Claborn KR, Meier E, Miller MB, Leffingwell TR. A systematic review of treatment fatigue among HIV-infected patients prescribed antiretroviral therapy. *Psychol Health Med* [Internet]. 2015 Apr 3 [cited 2024 Nov 1];20(3):255–65. Available from: <http://www.tandfonline.com/doi/abs/10.1080/13548506.2014.945601>.
 56. Arem H, Nakyanjo N, Kagaayi J, Mulamba J, Nakigozi G, Serwadda D, et al. Peer Health Workers and AIDS Care in Rakai, Uganda: A Mixed Methods Operations Research Evaluation of a Cluster-Randomized Trial. *AIDS Patient Care STDs* [Internet]. 2011 Dec [cited 2024 Jun 5];25(12):719–24. Available from: <https://www.liebertpub.com/doi/abs/10.1089/apc.2010.0349>.
 57. Demisse TL, Aliyu SA, Kitila SB, Tafesse TT, Gelaw KA, Zerihun MS. Utilization of preconception care and associated factors among reproductive age group women in Debre Birhan town, North Shewa, Ethiopia. *Reprod Health* [Internet]. 2019 Dec [cited 2024 May 30];16(1):96. Available from: <https://reproductive-health-journal.biomedcentral.com/articles/10.1186/s12978-019-0758-x>.
 58. Ujiji, OA, Ekström, AM, Ilako, F, Indalo, D, Wamalwa, D & Rubenson, B 2011, “Reasoning and deciding PMTCT-adherence during pregnancy among women living with HIV in Kenya,” *Culture Health & Sexuality*, 13(7):829–840.
 59. Chaudoir SR, Fisher JD, Simoni JM. Understanding HIV disclosure: A review and application of the Disclosure Processes Model. *Soc Sci Med* [Internet]. 2011 May [cited 2024 Aug 12];72(10):1618–29. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0277953611001912>.
 60. Balcha TT, Lecerof SS, Jeppsson AR. Strategic Challenges of PMTCT Program Implementation in Ethiopia. *J Int Assoc Physicians AIDS Care* [Internet]. 2011 May [cited 2024 Nov 1];10(3):187–92. Available from: <https://journals.sagepub.com/doi/10.1177/1545109710369935>.
 61. O’Gorman, DA, Nyirenda, LJ & Theobald, SJ 2010, “Prevention of mother-to-child transmission of HIV infection: Views and perceptions about swallowing nevirapine in rural Lilongwe, Malawi,” *BMC Public Health*, 10(1):354.
 62. Msuya, SE, Mbizvo, EM, Hussain, A, Uriyo, J, Sam, NE & Stray-Pedersen, B 2008, “Low male partner participation in antenatal HIV counseling and testing in northern Tanzania: implications for preventive programs,” *AIDS Care*, 20(6):700–709.
 63. Barigye, H, Levin, J, Maher, D, Tindiwegi, G, Atuhumuza, E, Nakibinge, S & Grosskurth, H 2010, “Operational evaluation of a service for prevention of mother-to-child transmission of HIV in rural Uganda: barriers to uptake of single-dose nevirapine and the role of birth reporting,” *Tropical Medicine & International Health*, 15(10):1163–1171.

64. Hatcher AM, Brittain K, Phillips TK, Zerbe A, Abrams EJ, Myer L. Longitudinal association between intimate partner violence and viral suppression during pregnancy and postpartum in South African women. *AIDS* [Internet]. 2021 Apr 1 [cited 2024 Aug 12];35(5):791–9. Available from: <https://journals.lww.com/10.1097/QAD.0000000000002796>
65. Mephram, S, Zondi, Z, Mbuyazi, A, Mkhwanazi, N & Newell, ML 2011, “Challenges in PMTCT antiretroviral adherence in northern KwaZulu-Natal, South Africa,” *AIDS Care*, 23(6):741–747.
66. Tran BX, Phan HT, Latkin CA, Nguyen HLT, Hoang CL, Ho CSH, et al. Understanding Global HIV Stigma and Discrimination: Are Contextual Factors Sufficiently Studied? (GAPRESEARCH). *Int J Environ Res Public Health*. 2019 May 29;16(11):1899.
67. Kasenga, F, Hurtig, A-K & Emmelin, M 2008, “HIV-positive women’s experiences of a PMTCT programme in rural Malawi,” *Midwifery*, 26(1):27–37.
68. Blake Helms C, Turan JM, Atkins G, Kempf MC, Clay OJ, Raper JL, et al. Interpersonal Mechanisms Contributing to the Association Between HIV-Related Internalized Stigma and Medication Adherence. *AIDS Behav* [Internet]. 2017 Jan [cited 2024 Jun 5];21(1):238–47. Available from: <http://link.springer.com/10.1007/s10461-016-1320-2>
69. Fekete EM, Williams SL, Skinta MD. Internalised HIV-stigma, loneliness, depressive symptoms, and sleep quality in people living with HIV. *Psychol Health* [Internet]. 2018 Mar 4 [cited 2024 Jun 5];33(3):398–415. Available from: <https://www.tandfonline.com/doi/full/10.1080/08870446.2017.1357816>
70. Ashaba S, Cooper-Vince C, Maling S, Rukundo GZ, Akena D, Tsai AC. Internalized HIV stigma, bullying, major depressive disorder, and high-risk suicidality among HIV-positive adolescents in rural Uganda. *Glob Ment Health* [Internet]. 2018 [cited 2024 Jun 5];5: e22. Available from: https://www.cambridge.org/core/product/identifier/S2054425118000158/type/journal_article
71. Musheke M, Ntalasha H, Gari S, Mckenzie O, Bond V, Martin-Hilber A, et al. A systematic review of qualitative findings on factors enabling and deterring uptake of HIV testing in Sub-Saharan Africa. *BMC Public Health* [Internet]. 2013 Mar 11 [cited 2024 Jul 23]; 13:220. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3610106/>
72. Sprague, C, Chersich, MF & Black, V 2011, “Health system weaknesses constrain access to PMTCT and maternal HIV services in South Africa: a qualitative enquiry,” *AIDS Research and Therapy*, 8(1):10.
73. Winestone, LE, Bukusi, EA, Cohen, CR, Kwaro, D, Schmidt, NC & Turan, JM 2011b, “Acceptability and feasibility of integration of HIV care services into antenatal clinics in rural Kenya: A qualitative provider interview study,” *Global Public Health*, 7(2):149–163.
74. Pellowski JA. Barriers to Care for Rural People Living With HIV: A Review of Domestic Research and Health Care Models. *J Assoc Nurses AIDS Care* [Internet]. 2013 Sep [cited 2024 Jun 12];24(5):422–37. Available from: <https://journals.lww.com/00001782-201309000-00008>.

75. Somi N, Dear N, Reed D, Parikh A, Lwilla A, Bahemana E, et al. Perceived satisfaction with HIV care and its association with adherence to antiretroviral therapy and viral suppression in the African Cohort Study. *AIDS Res Ther* [Internet]. 2021 Dec [cited 2024 Jun 7];18(1):89. Available from: <https://aidsrestherapy.biomedcentral.com/articles/10.1186/s12981-021-00414-3>
76. Luna-Mireles Y, Doubova SV, Pérez-Cuevas R, Luna-Mireles Y, Doubova SV, Pérez-Cuevas R. Quality of health care and viral suppression among human immunodeficiency virus patients. *Rev Investig Clínica* [Internet]. 2019 Oct [cited 2024 Jun 7];71(5):330–8. Available from: http://www.scielo.org.mx/scielo.php?script=sci_abstract&pid=S0034-83762019000500330&lng=es&nrm=iso&tlng=en
77. Stinson K, Myer L. Barriers to initiating antiretroviral therapy during pregnancy: a qualitative study of women attending services in Cape Town, South Africa. *Afr J AIDS Res* [Internet]. 2012 Mar [cited 2024 May 30];11(1):65–73. Available from: <http://www.tandfonline.com/doi/abs/10.2989/16085906.2012.671263>
78. Hossain F, Hasan M, Begum N, Mohan D, Verghis S, Jahan NK. Exploring the barriers to the antiretroviral therapy adherence among people living with HIV in Bangladesh: A qualitative approach. Todd CS, editor. *PLOS ONE* [Internet]. 2022 Oct 21 [cited 2024 May 30];17(10): e0276575. Available from: <https://dx.plos.org/10.1371/journal.pone.0276575>
79. World Health Organization. women and HIV/aids. in: *Counselling for Maternal and Newborn Health Care: A Handbook for Building Skills* [Internet]. World Health Organization; 2013 [cited 2024 Aug 19]. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK304180/>
80. Peltzer, K, Mlambo, M, Phaswana-Mafuya, N & Ladzani, R 2010, “Determinants of adherence to a single-dose nevirapine regimen for the prevention of mother-to-child HIV transmission in Gert Sibande district in South Africa,” *Acta Paediatrica*, 99(5):699–704.
81. Kinuthia, J, Kiarie, JN, Farquhar, C, Richardson, BA, Nduati, R, Mbori-Ngacha, D & John-Stewart, G 2011, “Uptake of prevention of mother to child transmission interventions in Kenya: health systems are more influential than stigma,” *Journal of the International AIDS Society*, 14(1):61.
82. Laher, F, Cescon, A, Lazarus, E, Kaida, A, Makongoza, M, Hogg, RS, Soon, CN, Miller, CL & Gray, G 2010, “Conversations with Mothers: Exploring Reasons for Prevention of Mother-to-Child Transmission (PMTCT) Failures in the Era of Programmatic Scale-Up in Soweto, South Africa,” *AIDS and Behavior*, 16(1):91–98.
83. Wessels J, Sherman G, Bamford L, Makua M, Ntloana M, Nuttall J, et al. The updated South African National Guideline for the Prevention of Mother to Child Transmission of Communicable Infections (2019). *South Afr J HIV Med* [Internet]. 2020 Jul 8 [cited 2024 Oct 31];21(1). Available from: <http://www.sajhivmed.org.za/index.php/HIVMED/article/view/1079>
84. Joint United Nations Programme on HIV/AIDS (UNAIDS) 2015, *Towards the Elimination of New HIV Infections Among Children and Keeping Their Mothers Alive: 2015 Progress Report on the Global Plan*. Available from: https://www.unaids.org/sites/default/files/media_asset/JC2774_2015ProgressReport_GlobalPlan_en.pdf.

85. Gunn JKL, Asaolu IO, Center KE, Gibson SJ, Wightman P, Ezeanolue EE, et al. Antenatal care and uptake of HIV testing among pregnant women in sub-Saharan Africa: a cross-sectional study. *J Int AIDS Soc* [Internet]. 2016 Jan 18 [cited 2024 Aug 13];19(1):20605. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4718968/>
86. Myer L, Phillips TK. Beyond “Option B+”: Understanding Antiretroviral Therapy (ART) Adherence, Retention in Care and Engagement in ART Services Among Pregnant and Postpartum Women Initiating Therapy in Sub-Saharan Africa. *JAIDS J Acquir Immune Defic Syndr* [Internet]. 2017 Jun 1 [cited 2024 Aug 13];75(2): S115–22. Available from: <https://journals.lww.com/00126334-201706011-00003>
87. Maingi M, Stark AH, Iron-Segev S. The impact of Option B+ on mother-to-child transmission of HIV in Africa: A systematic review. *Trop Med Int Health* [Internet]. 2022 Jun [cited 2024 Aug 13];27(6):553–63. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9328372/>
88. District Health Barometer 2015_16.pdf [Internet]. [cited 2024 Jun 10]. Available from: https://www.hst.org.za/publications/District%20Health%20Barometers/District%20Health%20Barometer%202015_16.pdf.
89. Goga A, Jackson D, Lombard C, Ramokolo V, Ngandu N, Sherman G, Puren A, Doherty T, Bhardwaj S, Noveve N, Ramraj T, Magasana V, Singh Y, Pillay Y. Highest risk of mother to child transmission of HIV or death in the first 6 months postpartum: results from 18-month follow-up of an HIV-exposed national cohort, South Africa. *Journal of the International AIDS Society*, 2016, 19, 27-28.
90. Eisinger RW, Dieffenbach CW, Fauci AS. HIV Viral Load and Transmissibility of HIV Infection: Undetectable Equals Untransmittable. *JAMA* [Internet]. 2019 Feb 5 [cited 2024 Jun 12];321(5):451. Available from: <http://jama.jamanetwork.com/article.aspx?doi=10.1001/jama.2018.21167>
91. STATA. The complete statistical software for data science [Internet]. 2025. Available from: <https://www.stata.com/>
92. Doyle T, Smith C, Vitiello P, Cambiano V, Johnson M, Owen A, et al. The importance of HIV RNA detection below 50 copies per mL in HIV-positive patients on antiretroviral therapy: an observational study. *The Lancet* [Internet]. 2014 Feb [cited 2024 Nov 2];383: S44. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S014067361460307X>
93. Southern African HIV Clinicians Society [Internet]. [cited 2025 Jan 22]. Available from: <https://sahivsoc.org/Guidelines/Module8>
94. Kleinert S. Singapore Statement: a global agreement on responsible research conduct. *The Lancet* [Internet]. 2010 Oct [cited 2024 Sep 5];376(9747):1125–7. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0140673610614560>
95. Pillay Y, Pienaar S, Barron P, Zondi T. Impact of COVID-19 on routine primary healthcare services in South Africa. *S Afr Med J* [Internet]. 2021 May 17 [cited 2024 Nov 5];111(8):714. Available from: <http://www.samj.org.za/index.php/samj/article/view/13303>

96. Freer J, Mudaly V. HIV and covid-19 in South Africa. *BMJ* [Internet]. 2022 Jan 27 [cited 2024 Nov 5]; e069807. Available from: <https://www.bmj.com/lookup/doi/10.1136/bmj-2021-069807>.
97. De Waard L, Langenegger E, Erasmus K, Van Der Merwe T, Olivier SE, Du Toit N, et al. Maternal and neonatal outcomes of COVID-19 in a high-risk pregnant cohort with and without HIV. *S Afr Med J* [Internet]. 2021 Dec 2 [cited 2024 Nov 5];111(12):1174. Available from: <http://www.samj.org.za/index.php/samj/article/view/13466>
98. Jahan R, Zou P, Huang Y, Jibb L. Impact of MomConnect Program in South Africa: A Narrative Review. *Online J Nurs Inform*. 2020 Jul 1; 24:211.
99. Mahanjana SK, Ledibane T, Sherman GG, Murray TY, Mazanderani AFH. Retrospective review of maternal HIV viral load electronic gatekeeping codes in South Africa. *South Afr J HIV Med* [Internet]. 2024 Feb 20 [cited 2024 Nov 5];25(1). Available from: <http://www.sajhivmed.org.za/index.php/HIVMED/article/view/1539>
100. The Mentor Mother Programme | Philani [Internet]. [cited 2024 Oct 29]. Available from: <http://www.philani.org.za/what-we-do/the-mentor-mother-programme/>
101. Willingness and Feasibility of Using Injectable Antiretroviral Therapy among Women who Retained and Disengaged from Prevention of Mother to Child HIV Transmission Programs in Uganda | UCSF-Bay Area Center for AIDS Research (CFAR) [Internet]. [cited 2025 Jan 15]. Available from: <https://cfar.ucsf.edu/award/willingness-and-feasibility-using-injectable-antiretroviral-therapy-among-women-who-retained>
102. Long-acting injectable cabotegravir for HIV prevention is safe in pregnancy | National Institutes of Health (NIH) [Internet]. [cited 2025 Jan 15]. Available from: <https://www.nih.gov/news-events/news-releases/long-acting-injectable-cabotegravir-hiv-prevention-safe-pregnancy>
103. AIDS 2024: CAB-LA Pregnancy Safety Data from HPTN 084 | The HIV Prevention Trials Network [Internet]. [cited 2025 Jan 15]. Available from: <https://www.hptn.org/news-and-events/announcements/aids-2024-cab-la-pregnancy-safety-data-from-hptn-084>
104. Okonji, EF, Mukumbang, FC, Orth, Z, Vickerman-Delport, SA & Van Wyk, B 2020, "Psychosocial support interventions for improved adherence and retention in ART care for young people living with HIV (10–24 years): a scoping review," *BMC Public Health*, 2020 Dec 1;20(1):1841.
105. Our Enable Programme - One to One Africa [Internet]. [cited 2024 Oct 29]. Available from: <https://www.onetooneafrica.org/enable/>
106. Jinga N, Mongwenyana C, Moolla A, Maletse G, Onoya D. Reasons for late presentation for antenatal care, healthcare providers' perspective. *BMC Health Serv Res* [Internet]. 2019 Dec [cited 2024 Oct 28];19(1):1016. Available from: <https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4855-x>
107. Matlala, SF & Ntuli, TS 2021b, Prevalence and factors contributing to late antenatal care booking amongst pregnant women in primary health care facilities at Dikgale-Mamabolo Local Area, Limpopo Province [Internet]. [cited 2024 Oct 28]. Available from: <http://ulspace.ul.ac.za/handle/10386/3796>.

108. Patel K, Huo Y, Jao J, Powis KM, Williams PL, Kacanek D, et al. Dolutegravir in Pregnancy as Compared with Current HIV Regimens in the United States. *N Engl J Med* [Internet]. 2022 Sep [cited 2024 Oct 28];387(9):799–809. Available from: <http://www.nejm.org/doi/10.1056/NEJMoa2200600>
109. Bangalee A, Hanley S, Bangalee V. Dolutegravir as first-line antiretroviral therapy in South Africa: Beware the one-size-fits-all approach. *S Afr Med J* [Internet]. 2022 Oct [cited 2024 Oct 28];112(10):787–90. Available from: <https://journals.co.za/doi/full/10.7196/SAMJ.2022.v112i10.16596>.
110. Antenatal-survey-2022-report_National_Provincial_12Jul2023_Clean_01.pdf [Internet]. [cited 2024 Oct 15]. Available from: https://www.nicd.ac.za/wp-content/uploads/2024/01/Antenatal-survey-2022-report_National_Provincial_12Jul2023_Clean_01.pdf.

APPENDICES

Appendix One: Plagiarism declaration report



PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Ellen Tendai Segula (Student number: 837872) am a student registered for the degree of Master of Science in Epidemiology (IDE) in the academic year 2025.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature:  Date: 16/8/25

Appendix Two: Ethical Clearance Certificate



R14/49 Mrs Ellen Tendai Segula

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) CLEARANCE CERTIFICATE NO. M240319 M240520-D-0001

NAME: Mrs Ellen Tendai Segula
(Principal Investigator)

DEGREE: MSc in Epidemiology (Infectious Diseases)

DEPARTMENT: School of Public Health

PROJECT TITLE: Prevalence and determinants of viral load suppression among pregnant women living with HIV, attending first antenatal care visit in South Africa

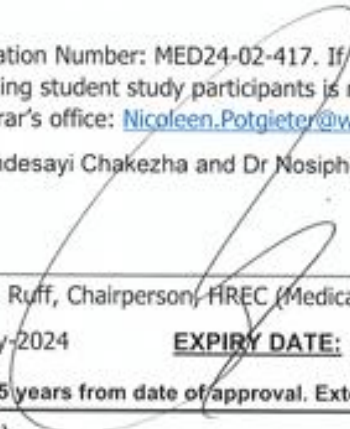
DATE CONSIDERED: 28-Mar-2024

DECISION: Approved unconditionally

CONDITIONS: N/A

NOTE: Application Number: MED24-02-417. If contact information regarding student study participants is required, please contact the Registrar's office: Nicoleen.Potgieter@wits.ac.za

SUPERVISORS: Dr Tendesayi Chakezha and Dr Nosipho Shangase

APPROVED BY: 
Prof P. Ruff, Chairperson, HREC (Medical)

DATE OF APPROVAL: 20-May-2024 **EXPIRY DATE:** 19-May-2029

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATOR(S)

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. I agree to submit a yearly progress report in the month date of convened meeting each year until study is closed. Failure to submit annual report will result in ethics clearance certificate suspension. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. Unreported changes to the application may invalidate the clearance given by the HREC (Medical). Email a signed copy of ethics clearance certificate to HREC-Medical.ResearchOffice@wits.ac.za



Signature of Principal Investigator

25th May, 2024

Date

Appendix Three: Turnitin Report

Turnitin report Ellen Tendai Segula.docx			
ORIGINALITY REPORT			
8%	7%	4%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS
PRIMARY SOURCES			
1	www.ncbi.nlm.nih.gov Internet Source	1%	
2	www.nicd.ac.za Internet Source	1%	
3	www.science.gov Internet Source	<1%	
4	www.scielo.br Internet Source	<1%	

Turnitin

Appendix Four; Primary Study Questionnaire

 NATIONAL INSTITUTE FOR COMMUNICABLE DISEASES Division of the National Health Laboratory Service		EPISODE NO. BARCODE FOR LAB USE		NATIONAL 2019 ANTENATAL SENTINEL HIV SURVEY, SOUTH AFRICA	
		GAUTENG			

GEOGRAPHIC	A. GEOGRAPHIC INFORMATION									
	A1. Province ☐ Eastern Cape ☐ Free State ☒ Gauteng ☐ KwaZulu-Natal ☐ Limpopo ☐ Mpumalanga ☐ Northern Cape ☐ North West ☐ Western Cape									
	A2. District ☐ Ekurhuleni ☐ Johannesburg ☐ Sedibeng ☐ Tshwane ☐ West Rand									
	A3. Name of Sentinel Clinic									
	A4. Facility Code (see back of the cover page for code)					A5. Client Folder / HPRN Number				

SPECIMEN	B. SPECIMEN INFORMATION									
	B1. Collection Date D D M M 2019					B2. Test Requested ☒ HIV Elisa ANS				

C. Survey enrolment questions *(Note: the following section should be completed for all women including those who refuse to participate in the survey)*

C1. Are you pregnant? Yes ☐ No ☐

C2. How old are you (in years)?

C3. What is your race? African ☐ Asian ☐ Coloured ☐ White ☐ Other ☐

C4. What is your relationship with the father of the child?

Married ☐
 Living together/co-habiting ☐
 Not living together but in a relationship ☐
 No relationship ☐

C5. Is this her first antenatal clinic visit? (review medical record):

Yes ☐ No 2nd visit ☐ No 3rd visit ☐ No ≥ 4th visit ☐

D. Consent for participating in current survey

It has been explained to me and I understand what the antenatal survey is about, and I agree to participate in the survey

Yes ☐ No ☐

Participant signature

Nurse's signature

Date

Date

E. Consent for storage and future use of your information and blood sample

I agree to the use of blood specimen for future studies Yes ☐ No ☐

Participant signature

Nurse's signature

Date

Date

Nurses name (please print as it appears on ID):

F. Demographic and clinical information

F1. How old is the father of this baby? Don't know

F2. Is the father of this baby older than you by 5 years or more? Yes No Don't know

F3. What is your highest completed level of education? None Primary Secondary Tertiary

F4. How many times have you been pregnant including this current pregnancy? 1 (one) 2 (two) 3 (three) 4 (four) and above

F5. How many live babies have you delivered? 0 (zero) 1 (one) 2 (two) 3 (three) 4 (four) and above

F6. Gestational age at today's visit (in weeks) (review medical record)

F7. Gestational age at first antenatal care booking (in weeks) (review medical record)

F8. Just before I became pregnant:

I intended to get pregnant

My intention kept changing

I did not intend to get pregnant

F9. In the month that I became pregnant:

I/we were not using contraception

I/we were using contraception but not on every occasion

I/we were always using contraception but knew the method had failed (i.e. broke, moved, came off, came out, not worked etc) at least once

I/we were always using contraception

G. HIV status

G1. Have you been tested for HIV before this pregnancy, if yes when?

Never tested before this pregnancy

Tested <= 1 year before this pregnancy

Tested 1-2 years before this pregnancy

Tested >2 years before this pregnancy

G2. What is the participant's latest HIV status (from her medical records)?

No HIV status recorded

Participant refused testing

Test not offered

Negative from test done in previous ANC visit

Negative from test done today

HIV positive

Discrepant result

G3. If HIV positive, when was she first diagnosed HIV positive?

Positive before this pregnancy Tested positive during previous antenatal visit Tested positive today

G4. If reported HIV positive, is she on ARVs? If yes when did she start (review medical record):

Yes, before pregnancy (i.e. already on ART at time of first antenatal visit) Yes, initiated today

Yes, initiated in prior antenatal visit at 1st trimester Yes, initiated in prior antenatal visit at 2nd trimester

Yes, initiated in prior antenatal visit at 3rd trimester No

G5. If taking ARVs, which ARV regimen is she taking (review medical record):

Dolutegravir (DTG)-based regimen (TLD) Efavirenz (EFV)-based regimen Second line regimen

Other (specify) _____

H. Viral load testing (if reported HIV positive complete this section by reviewing the participant's medical record)

H1. Is there a record showing viral load (VL) test was done for the participant during pregnancy?

Yes ☐ No ☐ Not due for viral load ☐

H2. If VL was done, has the VL test result been documented? Yes ☐ No ☐

H3. If VL is documented, what is the most recent VL result from test done during this pregnancy?

<=49 copies/ml ☐ 50-999 copies/ml ☐ >=1000 copies/ml ☐

H4. Date of most recent VL test DD/MM/YYYY

I. If the participant is HIV negative ask the following question:

This section is about pre-exposure prophylaxis (PrEP). PrEP is a pill taken by HIV negative people to reduce the risk of getting HIV

I1. In the past 12 months, I had:

More than 1 sexual partners ☐ Had only 1 partner ☐

I2. My current sexual partner(s) is/are:

HIV positive ☐ HIV negative ☐ Don't know his/their status ☐ Don't have sexual partner ☐

I3. Do you consider yourself to be at risk of getting HIV: Yes ☐ No ☐

I4. Have you ever heard of PrEP before today? Yes ☐ No ☐

I5. Have you been taking PrEP before this pregnancy? Yes ☐ No ☐

I6. Are you currently taking PrEP? Yes ☐ No ☐

J. SYPHILIS TESTING

J1. Is there a record showing syphilis test was done for the participant during this pregnancy? Yes ☐ No ☐

J2. If syphilis test was done, which type of test was done RPR ☐ point of care rapid test ☐

J3. If syphilis test was done, what is the result? Positive ☐ Negative ☐ Pending (in lab) ☐ Not in file ☐

J4. If the result was positive, did the patient receive treatment for syphilis? Yes ☐ No ☐

J5. If she did receive treatment, was this Benzathine Penicilin (Bicillin)? Yes ☐ No ☐

This questionnaire will be re-designed to fit in one page (back to back print) and to make it readable on OMR scanner