

UNIVERSITY OF THE WITWATERSRAND

FACULTY OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

PREVALENCE AND FACTORS ASSOCIATED WITH VIROLOGICAL NON-SUPPRESSION AMONGST HIV POSITIVE PREGNANT AND LACTATING ADULT WOMEN IN THE KINGDOM OF ESWATINI IN 2016-2017

Name: Mpumelelo Ndlangamandla

Student Number: 320775

Protocol submitted for the Degree: MSc Epidemiology and Biostatistics

Supervisor: Prof. Jonathan Levin, School of Public Health, Wits University

June 2023

Candidate's declaration

I declare that this research report is my own work. This report is submitted in partial fulfilment of the requirements for the Master of Science in Epidemiology (MSc) degree specializing in the field of Epidemiology and Biostatistics at the University of the Witwatersrand. This report has not been previously submitted to any other university for any degree or examination.



Mr. Mpumelelo Ndlangamandla

16th day of January 2023

Dedication

To my first-born daughter Luyandza Ndlangamandla who puts a smile to my face and shows me unconditional love and my mother Sihle Ndlangamandla who has supported me throughout my study endeavours.

Abstract

Antiretroviral treatment (ART) is the primary intervention for preventing mother to child transmission of HIV service package. The likelihood of vertical transmission of HIV can be drastically reduced by using ART. The World Health Organization (WHO) recommends ART initiation in pregnant and lactating women living with HIV regardless of WHO clinical staging and thereafter to continue combination Antiretroviral Therapy (cART) for life. There are some challenges in implementing the WHO recommendations in settings where many women cannot attend antenatal care services due to social or economic barriers or structural barriers and even fewer women attend postnatal care services.

The objectives of this study are to determine the prevalence of virological non-suppression among pregnant and lactating women living with HIV, to quantify the association between self-reported ART use and virological non-suppression and determine socio-demographic, clinical and behavioural characteristics associated with virological non-suppression among pregnant and lactating women living with HIV.

This is a cross-sectional study using secondary data from the Swaziland HIV Incidence Survey. The primary study was a population-based survey which was nationally representative, using a cross-sectional study design conducted in 2016-2017 in the Kingdom of Eswatini employing a two-stage stratified cluster sample design. This study sample included adult women living with HIV who were either pregnant or lactating at the time of the survey. Data analysis was conducted using Stata 17. The data analysis made use of sampling weights and clustering of individuals within each enumeration area using weighted clustered logistic regression survey analysis commands in Stata.

A total of 195 adult women living with HIV were included in the survey with a median age of 28 years old. Among the women, 104 (54.4%) were either married or cohabiting with someone, and 151 (71.9%) were living in a rural setting. Only 77 (38.8%) had attained primary education as their highest level of education while 122 (63.8%) were lactating. A total of 120 (62%) reported being on ARVs and 158 (81.8%) being virally suppressed. The overall virological non-suppression prevalence of 36.8% was higher than the UNAIDS target of 10% by 2020 to speed up HIV elimination. In a multivariable analysis, two risk factors remained statistically significant. Women who were aged 17 to 24 years old were almost five times more likely to be virologically non-suppressed (aOR=4.7, 95% CI 1.8 - 11.8, p=0.001) while women who did not report ARV use during pregnancy were eight times more likely to have virological non-

suppression (aOR=8.1, 95% CI 3.0 - 21.8, $p<0.001$). Maternal age was dichotomised with the younger group compared to the older group (17-24 years, vs 25+ years). An additional analysis excluding self-reported ARV use at pregnancy found that virological non-suppression was associated with maternal age (OR=5.5, 95% CI 2.3 – 13.7, $p<0.001$) and number of sexual partners in the previous 12 months (OR=7.9, 95% CI 1.6 – 40.5, $p=0.013$). Maternal age was dichotomised with the younger group compared to the older group (17-24 years, vs 25+ years).

The study found that virological non-suppression was associated with maternal age and ARV use at pregnancy. The additional analysis also found a strong association with maternal age and number of sexual partners the women reported having in the previous twelve months. However, the primary study was not powered to detect differences in virological non-suppression among our population of interest. The sample size was also small, which limited the ability to investigate other possible risk factors.

To help the country address the identified gaps, I would recommend the scale up of the DREAMS program and strict following of HIV guidelines to actively monitor viral load and ART uptake during pregnancy and lactation. In addition, messaging around avoidance of multiple sexual partners should be strengthened.

Acknowledgement

My acknowledgements go out to my research supervisor Prof. Jonathan Levin for the support he provided me during my project write up and Dr Zodwa Ndlovu who kept me on track as I worked on this report.

Table of Contents

Candidate's declaration	I
Dedication	II
Abstract	III
Acknowledgement	V
Table of Contents	VI
List of abbreviations	1
Chapter One: Introduction	2
1.1 Background.....	2
1.2 Literature review.....	6
1.2.1 PMTCT policies and practices.....	6
1.2.2 Viral load suppression.....	7
1.4 Problem statement and justification.....	9
1.5 Research question	10
1.6 Aim	10
1.7 Objectives	10
Chapter Two: Methodology	11
2.1 Study design.....	11
2.2 Source of data	11
2.3 Study population	11
2.4 Study sample	11
2.5 Variables	12
2.6 Data management.....	12
2.7 Data analysis	12
2.9 Ethical considerations	13
Chapter Three: Results	14
3.1 Population characteristics	14
3.2 Prevalence of virological non-suppression	16
3.3 Quantification of ARV use and VLS	16
3.4 Factors associated with viral load non-suppression.....	18
Chapter Four: Discussion and Recommendations	21
References	24
Appendices	28

List of tables

<i>Table 1:</i> Background characteristics of study participants	15
<i>Table 2:</i> Viral load non-suppression prevalence among study participants	17
<i>Table 3:</i> Crude and adjusted factors associated with viral load non-suppression	19
<i>Table 4:</i> Crude and adjusted factors associated with viral load non-suppression (Excluding ARV use)	20

List of abbreviations

AIDS	Acquired Immunodeficiency Syndrome
ANC	Antenatal Care
ART	Anti-retroviral Therapy
cART	Combination Anti-retroviral Therapy
EMTCT	Elimination of Mother to Child Transmission
HIV	Human Immunodeficiency Virus
LMIC	Low- and Middle-Income Countries
MTCT	Mother to Child Transmission
PLHIV	People Living with HIV
PMTCT	Prevention of Mother to Child Transmission
SHIMS	Swaziland HIV Incidence Measurement Survey
VL	Viral Load
VLS	Viral Load Suppression
WHO	World Health Organization

Chapter One: Introduction

1.1 Background

Globally it was estimated in 2017 that there were 37 million people living with the Human Immunodeficiency Virus (HIV) and about 22 million were receiving Anti-Retroviral Therapy (ART) to suppress the virus. There were approximately 2 million HIV incident cases, and 1 million individuals worldwide were reported to have died as a result of opportunistic infections related to Acquired Immune Deficiency Syndrome (AIDS) in the year 2017 (Desta *et al.*, 2020). The Eastern and Southern African regions were the most affected by the HIV epidemic (Napyo *et al.*, 2020). Over the past two decades, a widespread setback in health benefits was triggered by the HIV epidemic in sub-Saharan Africa which in prior years had been improving significantly. This led to a drastic decline in life expectancy because of the high HIV prevalence, representing the devastation caused by HIV and AIDS on the African continent (Liotta *et al.*, 2015).

In Low and Middle-Income Countries (LMIC), about 18 million people living with HIV had started ART by 2016, which is an indication that effective HIV care and treatment had become a public health priority. However, the rapid scale-up of ART has increased the number of people needing second line drugs, because of treatment failure due to development of viral resistance. To maximize the durability of first-line regimens, patients newly started on ART should be closely monitored by having regular viral load monitoring and CD4 count tests. If HIV drug resistance is suspected, additional genotyping resistance tests should be conducted (Estill *et al.*, 2013). Access to ART in sub-Saharan Africa has been expanding, with an estimated 60% of HIV infected individuals receiving treatment in 2018 with a target of 95% by 2030 (Villa *et al.*, 2020). In 2017, HIV prevalence was highest in the sub-Saharan Africa region and ART coverage ranged between 65.7% in Lesotho and 85.7% in Eswatini (Dereje *et al.*, 2020). The primary intervention for Preventing Mother to Child Transmission (PMTCT) of HIV is the ART HIV service package, with secondary interventions being focusing HIV prevention interventions on women of reproductive age and long-term interventions being HIV care and treatment and family planning. The likelihood of vertical transmission of HIV can be drastically reduced by using ART (Gourlay *et al.*, 2013). The World Health Organization (WHO) in 2015 recommended that ART should be initiated in pregnant or lactating women living with HIV irrespective of CD4 count or WHO clinical staging and continued for life (World Health Organization, 2015). PMTCT using ART can nearly eliminate the vertical transmission of HIV and increase maternal survival (Chetty *et al.*, 2016). PMTCT has been a priority globally in both

programmatic implementation and in health research for the past two decades. Globally, the rapid scale-up of ART for PMTCT has led to more than two thirds of women living with HIV receiving ART for PMTCT in LMIC. Between 2009 and 2015, the scale up resulted in a decline of approximately 48% in Mother to Child Transmission (MTCT) of HIV (Hunt *et al.*, 2019). Pregnant or lactating women are a key group in ART programmes. In most countries, many adults living with HIV are woman of reproductive age, mostly diagnosed through PMTCT programmes during pregnancy when accessing antenatal care (ANC) services. HIV MTCT accounts for about 14% of new infections of HIV globally. It can occur during delivery, labour or pregnancy. Breastfeeding by a woman living with HIV without being on treatment increases the risk of transmission by between 5-20% (Kahungu *et al.*, 2018).

As a result of the high uptake of PMTCT, an estimated total of 1.1 million new vertical HIV transmissions have been averted among HIV exposed children. In addition, AIDS deaths declined by 45% among HIV infected women (Odeny *et al.*, 2018). The PMTCT option B+ policy recommends ART for all pregnant or lactating women who are diagnosed HIV+ and most eligible women start ART during pregnancy. The updated infant feeding recommendations allow breastfeeding beyond 1 year, hence the PMTCT services have to be offered beyond early infant diagnosis which is around 6 to 10 weeks postpartum. These services therefore extend until breastfeeding is terminated, and the infant's HIV status is documented (World Health Organization, 2019). Despite the rollout of the PMTCT B+ intervention programs, evidence suggests that among women and infants, the HIV prevalence in sub-Saharan Africa remains disproportionately high (Dereje *et al.*, 2020).

International organizations have pledged their commitment to support ART programs in sub-Saharan Africa, where women of reproductive age constitute more than 60% of people living with HIV (El-khatib *et al.*, 2011). Given the global widespread progress in PMTCT of HIV, during 2014, the World Health Organization launched the call to take steps in eliminating MTCT of HIV. Countries should achieve and maintain for one year, a population case rate of less than 50 among infants HIV infections per 100 000 live births due to MTCT and an HIV MTCT rate of less than 5% for countries lactating where lactation is standard of care for HIV positive women and less than 2% for countries where breast-feeding is not standard of care for HIV positive women. Countries that meet the global requirements are encouraged to apply for validation (World Health Organization, 2017). Initiating ART before giving birth and maintaining a VL of less than 50 copies/ml can reduce MTCT rates during pregnancy to levels below the WHO elimination of MTCT targets (Kabami *et al.*, 2021). In countries with a high antenatal care (ANC) HIV prevalence, these targets are a challenge and can only be achieved with very low

HIV rates of transmissions which may require total coverage of comprehensive PMTCT intervention packages (Pellowski *et al.*, 2019).

The effectiveness of ART can be accurately measured using viral load (VL) quantification. A persistently non-suppressed VL suggests poor adherence to ART or treatment failure and indicates a need to intervene. WHO guidelines now emphasize routine VL monitoring within ART programmes hence LMIC recognise VL monitoring as an important factor in provision of their ART services (Myer *et al.*, 2017). VL monitoring should enable early detection of possible treatment failure, inform effective targeted adherence counselling and switching of patients to other regimens reducing exposure to less effective regimens (Estill *et al.*, 2013). Whilst PMTC option B+ has led to increased rates of ART initiation in women living with HIV, there is little knowledge about sustained VL suppression at pregnancy, during delivery and at lactation which would be the key determinants of MTCT (Landes *et al.*, 2019).

High levels of suboptimal ART adherence and disengagement from care coupled with non-suppressed VL have been reported for pregnant and postpartum women who are HIV infected raising the risk of vertical transmission during pregnancy and breastfeeding. Non-suppressed VL requires active monitoring and interventions within ART programs (Lesosky *et al.*, 2021). As routine VL monitoring is limited in most countries in the sub-Saharan region, there are minimal attempts outside of the cohort studies of interest to estimate viral load suppression in pregnant and lactating women routinely within ART programs (Woldesenbet *et al.*, 2020). The expected expansion of VL monitoring of ART patients is constrained by barriers including an overburdened healthcare system, poor training, weak laboratory infrastructure, weak transportation system and financial constraints (Villa *et al.*, 2020). The benefits of implementing VL monitoring in the sub-Saharan region may include solutions which may reduce clinic visits promoting ART retention and improved clinical outcomes (Villa *et al.*, 2020).

Virological suppression and ART adherence is crucial during the breastfeeding period as there is on-going risk of MTCT. While the need for routine VL monitoring in people living with HIV has been recognised, there seems to be less VL monitoring specifically targeted towards pregnant and lactating women (Myer *et al.*, 2017). As an unsuppressed VL is associated with a risk of MTCT during pregnancy, it becomes important to investigate VL suppression and factors associated with unsuppressed VL in women who become pregnant whilst on ART. There is a proven link between ART duration and risk of MTCT, as lowest MTCT rates were observed in women starting ART before they were pregnant or early in their pregnancy. Time to VL suppression is related to the VL at the time of ART initiation (Gill *et al.*, 2016). Clinicians and people living with HIV and on ART must have timely access to VL results to make

informed clinical decisions where there is virological non-suppression. Suppressed VL improves patient health while also reducing the risk of HIV transmission. Over time, VL has been scaled up and is estimated to be at 60% in LMIC. Despite the increased financial investments in VL monitoring, often the test results are not timeously returned for clinical utilization (Boeke *et al.*, 2020). In settings where VL monitoring is not routine, treatment failures are detected late by when there may be extensive antiviral resistance (Kityo *et al.*, 2017).

While UNAIDS regularly publishes ART coverage estimates of VL suppression, there are limited population-based studies on VL suppression. In addition to the poor adherence among people living with HIV and high loss to follow-up rates among those on ART, VL suppression is suboptimal among those in the postpartum period (Yotebieng *et al.*, 2020).

1.2 Literature review

1.2.1 PMTCT policies and practices

One of the significant contributors to the HIV pandemic is the mother to child transmission of HIV which accounts for about 9% of new HIV infections globally (UNICEF *et al.*, 2021). WHO guidelines recommend initiation of ART which should be continued for life in all pregnant or breastfeeding women living with HIV, regardless of immunological status; this recommendation was previously known as PMTCT option B+. As a result of this recommendation, the risk of MTCT is reduced to less than 5% and hence providing the basis for early ART initiation of all pregnant or breastfeeding women living with HIV which reduces the risk of MTCT of HIV during pregnancy and benefits the health of the mother. Lifelong ART reduces MTCT risk during breastfeeding.

There are several challenges in implementing the WHO recommendations where many women are unable to attend antenatal care (ANC) services due to social or economic or structural barriers and even fewer women attend postnatal care (PNC) services. Most women attending ANC services are HIV naïve and when HIV testing is made available, many women have difficulty disclosing their HIV status. This makes it more difficult for them to adhere to ART. Many women do not attend all their ANC sessions during pregnancy and deliver at home making implementation of the PMTCT protocol difficult. Despite the relative simplicity of the PMTCT guidelines, there may be difficulties implementing the recommendations in weak health systems. In poorly resourced settings, the mother and child health services may face considerable difficulties in implementing the recommendations on a large scale. In high HIV prevalence countries, there is higher risk of MTCT during late pregnancy and breastfeeding due to undetected seroconversion (Medecins Sans Frontieres, 2020).

In a pooled analysis involving 51 studies, a total of 20,153 pregnant women living with HIV (PWLHIV) mostly from Kenya, South Africa, the United States and Zambia found that 75.7% of PWLHIV had >80% adherence to ART during pregnancy compared to an inadequate 53.0% ART adherence at the postpartum period. An analysis from large facilities in Malawi between 2011 and 2013 from women initiating ART during pregnancy and breast feeding, found that about 70% had adequate adherence within the first two years of starting ART. However, only 30% had maintained adequate ART adherence during their visits (Woldesenbet *et al.*, 2020). In Rwanda, VL suppression is estimated to be around 84.6% in women in a PMTCT B+ program during early postpartum or late pregnancy and 89.6% among women initiating ART during pregnancy and remaining in treatment for five years. A full understanding of the literature on

the extent of the impact of VL suppression on MTCT option B+ in the sub-Saharan African region is complicated by the variation in the definition of VLS among different authors (Landes *et al.*, 2019). The WHO defines VL suppression as HIV RNA below 1000 copies/mL (World Health Organization, 2015), Ngowi *et al* defined VL suppression to be HIV RNA <20 copies/mL in the Tanzanian study while Esber *et al* defined VL suppression as viral load <200 copies/mL in the African Cohort Study and a sub-Saharan Africa systematic review and meta-analysis by Nyoni *et al* based their VL suppression cut off at less than 400 and less than 500 HIV RNA copies/mL as specified by the individual studies (Ngowi *et al.*, 2022), (Esber *et al.*, 2022), (Nyoni *et al.*, 2020).

1.2.2 Viral load suppression

Patients responding well clinically within ART programmes normally have VL ≤ 1000 copies/mL (Ministry of Health Eswatini, 2015). Virological non-suppression suggests on-going replication of HIV which increases the risk of virological failure among patients. Drug resistance and poor ART adherence are notable causes of prolonged virological non-suppression. History of ART use is associated with virological non-suppression and drug resistance, i.e., exposure to a less effective regimen or a primary HIV infection by a resistant strain (Ntlantsana, Hift and Mphatswe, 2019). VL monitoring in pregnant or lactating women is critical as it keeps infants free of HIV and maintains maternal health. There is evidence of poor ART adherence during pregnancy and breastfeeding which is critical to avoid MTCT (Myer *et al.*, 2017).

Virological non-suppression is a public health risk which can lead to HIV drug resistance and lead to virological failure (Napyo *et al.*, 2020). Increased risk of virological failure and subsequent clinical progression may be because of poor adherence to ART. The relationship between VL outcomes and ART adherence is complex, previously PLHIV on ART needed adherence of 95% or higher to un-boosted protease inhibitor (PI) regimens to ensure VL suppression. However, with the current non-nucleoside reverse transcriptase inhibitor (NNRTI) and PI regimens an adherence level between 70-90% may achieve VL suppression (Gill *et al.*, 2016). Since the rollout of life-long ART in South Africa, the perinatal MTCT rate has been reduced from 3.5% to 1.5% at 6 weeks while vertical transmission was reported to be 0.9% in 2017. The HIV prevalence among pregnant and breastfeeding women remains high at 30%. There is a need to prioritize early initiation no ART given the high HIV prevalence, to reduce the MTCT rates to manageable levels through ensuring that women maintain a suppressed VL throughout pregnancy and breastfeeding (Kabami *et al.*, 2021).

Several factors have been identified as predictors of virological non-suppression, especially during pregnancy. These include a high VL prior to initiation of ART, starting ART late, recent HIV infections during pregnancy and poor ART adherence. Other social biological and behavioural factors influencing adherence and VLS during pregnancy include drug toxicity, treatment fatigue, nondisclosure of HIV status, alcohol abuse and absence of family support (Kabami *et al.*, 2021). In a Brazilian study, patients living in union (either married or cohabiting) were more likely to achieve VL suppression compared to participants not living in a union. Education lower than university, financial hardship and unemployment were associated with virological non-suppression in eight United Kingdom clinics among patients on ART (Mogosetsi, Mabuza and Ogunbanjo, 2018). A South African study found that among pregnant women with a median pre-ART VL of 10,000 copies/ml, the median duration to VL<1000 copies/ml was 24 days and to a VL<19 copies/ml was 94 days. (Gill *et al.*, 2016).

Due to existing health-system dynamics and patient barriers in most sub-Saharan African countries, ANC services are accessed late in pregnancy hence delaying starting ART and achieving VL suppression. Adherence to ART is also affected by social, behavioural, and biological factors including non-disclosure of HIV status, duration on ART, drug toxicity, heavy substance abuse and lack of family support (Woldesenbet *et al.*, 2020).

A study from HIV patients in Uganda found virological non-suppression to be associated with being younger, having active pulmonary tuberculosis (TB) and poor drug adherence whilst second- or third-line ART regimens were found to be protective against virological non-suppression. Morbidity and mortality risk is increased by drug resistance of HIV as it limits available treatment options (Bulage *et al.*, 2017).

Patient history data are very important in implementing corrective measures to address virological non-suppression as some factors which may lead to virological non-suppression may differ by population and setting (Desta *et al.*, 2020).

The risk of virological failure is increased using NNRTIs such as NVP as they have a low genetic barrier which is associated with developing mutations leading to drug resistance (Mwangi and van Wyk, 2019).

In Malawi, the introduction of the PMTCT B+ option increased the use of ART by 784% among pregnant woman a year after it was implemented. This increased uptake of ART resulted in a 67% decrease in MTCT. However, with poor retention in care, the program could not monitor the VL for these women, especially in the postpartum period. This led to women failing treatment while in HIV care (Chagomerana *et al.*, 2018).

Among children younger than 15 years, 90% of infections result from MTCT. In women attending ANC, the HIV prevalence in South Africa was 30% and varies significantly by province. The VL of the mother is one of the primary determinants of MTCT. Around 72% of pregnant women reached the desired ART adherence in LMIC, with adherence becoming poorer in the postpartum period. A cohort of women living with HIV on ANC was followed in the post-partum period, and a striking loss of suppression was observed, with only about 70% of the cohort maintaining steady viral suppression for a year (Ntlantsana, Hift and Mphatswe, 2019). A study in South Africa found that even after VLS is achieved, about 70% of women maintained VL suppression throughout the 322 days median follow-up time (Yotebieng et al., 2020).

There are few studies which have evaluated the extent of virological non-suppression among pregnant and breastfeeding women after the recommendation, implementation and scale up of PMTCT B+. The existing literature focuses on VL outcomes in women and populations outside of the PMTCT programs; therefore, additional knowledge is needed to understand the pregnant and breastfeeding women living with HIV, to better understand the existing gaps which will inform the elimination of MTCT.

1.3 Definition of terms

Virological non-suppression: Viral load copies greater than 1000 copies/ml

1.4 Problem statement and justification

Findings from the Eswatini HIV Incidence Measurement Survey (SHIMS) 2016/17 indicated a mother to child transmission rate of 12.8% among children below 18 months. (Ministry of Health Eswatini, 2019). This is high compared to other sub-Saharan African countries, which suggests that there are some existing gaps in the PMTCT programme in the country. Hence there is a need to investigate what may be the causes. One way to approach this is to investigate the behaviour of the mothers more at risk of transmitting HIV to their children. This study seeks to investigate the factors that could possibly be associated with Mother to Child transmission of HIV in the population. Understanding the underlying factors which are associated with virological non-suppression is crucial when developing interventions which are evidence based and country specific. The Kingdom still has a knowledge gap concerning these factors which are well established in other parts of the world. As such, findings from the study can provide critical information in shaping targeted interventions and formulation of policy to eliminate mother to child transmission of HIV.

1.5 Research question

What is the prevalence of, and factors associated with virological non suppression amongst pregnant and lactating adults in the Kingdom of Eswatini living with HIV?

1.6 Aim

The aim of the study is to determine the prevalence of and assess the factors associated with virological non-suppression amongst pregnant and lactating adult women living with HIV in the Kingdom of Eswatini

1.7 Objectives

1. Determine the prevalence of virological non-suppression amongst pregnant and lactating HIV-infected women.
2. To quantify the association between self-reported ART use and virological non-suppression
3. Determine socio-demographic, clinical and behavioural characteristics associated with virological non-suppression among pregnant and lactating HIV-infected women.

Chapter Two: Methodology

2.1 Study design

This study is a secondary analysis of the Eswatini HIV Incidence Measurement Survey (SHIMS) which used a cross-sectional study design.

2.2 Source of data

The primary study was a population-based, nationally representative cross-sectional, survey conducted in 2016 the Kingdom of Eswatini. The target population was children and adults excluding institutionalized populations.

The primary study employed a two-stage stratified cluster sampling design. The sampling frame encompassed all households in the country. It includes a total of 2,067 enumeration areas (EA), with 212,195 households. The country is stratified into four geographical regions namely Hhohho, Lubombo, Manzini and Shiselweni regions and stratified into rural and urban areas. Thereafter 286 EAs were sampled with probability proportional to size, the measure of size being the number of households in the EA. Each EA was defined by rural or urban status. In the second stage, households were randomly selected within each EA using an equal probability method.

Data were collected using mobile tablet devices with the questionnaire pre-programmed using Open Data Kit application. The adult questionnaire was administered to consenting participants.

The primary database can be obtained via this link (<https://phia-data.icap.columbia.edu/files>) after obtaining permission through the website as the data is now publicly available.

2.3 Study population

This study population consists of all HIV-infected adult women who were pregnant or lactating and living in Eswatini.

2.4 Study sample

This study sample comprises of all adult women testing HIV positive and who were either pregnant or lactating and who were found in sampled households at the time of the interview.

Inclusion criteria

- Women testing HIV positive
- Women with viral load results
- Women who are 15 years and older
- Women who are pregnant or lactating

A sample of 195 HIV-infected pregnant or lactating women with information on viral load is sufficient to estimate the proportion with virological non-suppression with an absolute precision of approximately ± 0.07 (i.e. to within 7%) assuming that roughly 50% of women had virological non-suppression

2.5 Variables

Outcome

Viral load category (VL $\leq$ 1000, VL $>$ 1000)

Demographic

Age, residence, education level

Exposures

SES, duration on ART, union type, number of sexual partners in the past 12 months, history of alcohol use, number of children

Survey design

Enumeration area, Region, Location, Sampling weights

2.6 Data management

Data were imported into Stata, a statistical package for data cleaning and analysis. The outcome variable was grouped into virological non-suppressed (viral load >1000 copies/ml) and virological suppressed (viral load ≤ 1000 copies/ml). Age was categorized into two groups for comparisons.

2.7 Data analysis

Data analysis was conducted using Stata SE 17. The data analysis considered the sampling weights and clustering of individuals within each EA, using the survey analysis commands in Stata. In statistical analysis, we used robust logistic regression which incorporated both survey weights and clustering and initially determined the association of each individual risk factor with the outcome variable.

Descriptive tables were disaggregated by the outcome variable categories “VL >1000 and VL ≤ 1000 ” for each explanatory variable, with frequencies and percentages to describe the population. Continuous variables were described using means and interquartile ranges. Test of association were conducted using the Rao-Scott adjustment to the chi-square test for clustered data (which uses an F-statistic) for categorical variables and means were compared by fitting a

simple survey linear regression model with a single term for VL category for continuous variables.

Univariable logistic regression models were fitted for each explanatory variable individually modelling the odds of virological non-suppression. A cut-off p-value of 0.20 was used to decide variables to be included in the multi-variable analysis. Age, area of residence (urban or rural) and region were included in the final model regardless of whether they were statistically significant.

In weighted and clustered multivariable logistic regression, explanatory variables with a p-value less than 0.1 were included in the final model. To assess the goodness of fit, the Hosmer-Lemeshow goodness-of-fit test was used to assess the goodness of fit.

2.9 Ethical considerations

Ethics approval was obtained from the Human Research Ethics Committee (HREC) of the University of the Witwatersrand with reference number M210829. The primary study obtained ethical approval from the Eswatini National Health Research Review Board.

Chapter Three: Results

This section presents findings from the study. Descriptive results are presented in tables using statistical frequencies and percentages and narratives will describe what is presented in the tables. Results of statistical models are presented using odds ratios, confidence intervals and p-values.

3.1 Population characteristics

Throughout the report, proportions will represent weighted percentages using survey weights. A total of 195 women were eligible for and used for the analysis with a mean age of 28 years. The eldest was 42 years old and the youngest was 17 years old.

Of the participants, (135 or 71.6%) were aged 25 years or older and (60 or 28.4%) were aged between 17 and 24 years old whilst (104 or 54.4%) were living in a union that is either they were married or cohabiting with a partner. Of the women, (57 or 32.2%) were residing in the Manzini region, (54 or 27.3%) were residing in the Hhohho region, (51 or 24.7%) were residing in the Lubombo region and (33 or 15.8%) were residing in the Shiselweni region. Most of the women (151 or 71.9%) were residing in a rural location and (80 or 42.3%) had attained secondary school level followed by (77 or 38.8%) with primary school education and (38 or 18.9%) with higher education. The largest number of participants (58 or 28.8%) were in the second wealth quintile, followed by (57 or 25.4%) in the lowest wealth quintile, while the least number of women (9 or 5.0%) were in the highest wealth quintile.

Most participants, (185 or 94.1%) reported having had none or one sexual partner in the past 12 months, with only (10 or 5.8%) reporting having had at least two sexual partners. Among the participants, (111 or 59.1%) reported having had three or more pregnancies whilst (84 or 40.9%) reported having had one or two pregnancies. Of the participants (120 or 62.1%) reported having used ARVs during their recent pregnancy while (75 or 37.9%) reported that they did not use ARVs at any stage of their last pregnancy. Most of the women (186 or 95.2%) reported not drinking alcohol at all and (122 or 63.8%) of the women were breastfeeding. (Table 1).

Table 1: Background characteristics of study participants

Variable	Frequency (N=195)	Percentage (%)
Age in years		
17-24	60	28.4
25+	135	71.6
Union type		
In union	104	54.4
Not in union	91	45.6
Location		
Urban	44	28.1
Rural	151	71.9
Region		
Hhohho	54	27.3
Lubombo	51	24.7
Manzini	57	32.2
Shiselweni	33	15.8
Education level		
Primary	77	38.8
Secondary	80	42.3
Higher	38	18.9
Wealth quintile		
Lowest	57	25.4
Second	58	28.8
Middle	32	16.4
Fourth	39	24.4
Highest	9	5.0
Sexual partners		
0-1	185	94.2
2+	10	5.8
Number of pregnancies		
1-2	84	40.9
3+	111	59.1
ARV use at pregnancy		
Yes	120	62.1
No	75	37.9
Alcohol use		
Yes	186	95.2
No	9	4.8
Women status		
Pregnant	73	36.2
Lactating	122	63.8

3.2 Prevalence of virological non-suppression

Of the 195 women, 37 (18.2%, 95% CI [12.8-23.6]) had viral loads above 1,000 copies per ml and thus had virological non-suppression. The prevalence of virological non-suppression was higher in the women aged between 17-24 years at 28.4% compared to women aged twenty-five years or older at 11.6%. Women who were not in a union had a higher prevalence of virological non-suppression at 26.2% compared to women who were living in union at 11.5%. Participants who were residing in an urban location had a virological non-suppression prevalence of 23.2% whilst women residing in a rural location had a prevalence of 16.2%. Women who were residing in the Hhohho region had a virological non-suppression prevalence of 22.5% followed by women residing in the Manzini region with a virological non-suppression prevalence of 19.5%, followed by women residing in the Lubombo region with a virological non-suppression prevalence of 14.5% and women from the Shiselweni region had the lowest virological non-suppression prevalence of 13.9%.

Women who had attained a secondary level of education had a virological non-suppression prevalence of 22.1% followed by women who had a higher level of education with a virological non-suppression prevalence of 16.5% and women with primary education level with a virological non-suppression prevalence of 14.8%. Women within the higher two wealth quintiles had a virological non-suppression prevalence of 19.0% whilst women in the lower three wealth quintiles had a virological non-suppression prevalence of 17.5%. Participants who reported having two or more sexual partners in the past twelve months had a virological non-suppression prevalence of 52.1% and women who reported having none or 1 sexual partner had a virological non-suppression prevalence of 16.1%. The virological non-suppression prevalence among those who had at-least two pregnancies was 24.2% while women with three or more pregnancies had a virologic non-suppression prevalence of 14.0%. Women who reported consuming alcohol had a virological non-suppression prevalence of 18.4% while those who reported that they did not drink alcohol had a virological non-suppression prevalence of 14.8%. (Table 2).

3.3 Quantification of ARV use and VLS

Of the 195 women in the study, 120 (62.1%) reported using ARVs to prevent mother to child transmission of HIV with 75 (37.9%) reporting not using ARVs at any point during their last pregnancy or lactation period. The prevalence of viral load non-suppression was higher at 36.8% among women who did not report using ARVs during their last pregnancy compared to 6.8% prevalence among women who reported using ARVs during their last pregnancy or at

lactation. Viral load non-suppression prevalence was higher among pregnant women than in lactating women (Table 1 and table 2).

Table 2: Viral load non-suppression prevalence among study participants

Variable	Frequency (N=195)	Unsuppressed (n=37)	Weighted Prevalence (%)
Age in years			
17-24	60	21	34.8
25+	135	16	11.6
Union type			
In union	104	14	11.5
Not in union	91	23	26.2
Location			
Urban	44	13	23.2
Rural	151	24	16.2
Region			
Hhohho	54	13	22.5
Lubombo	51	8	14.5
Manzini	57	12	19.5
Shiselweni	33	4	13.9
Education level			
Primary	77	12	14.8
Secondary	80	20	22.1
Higher	38	5	16.5
Wealth quintile			
Lowest	57	10	16.9
Second	58	11	18.1
Middle	32	6	18.7
Fourth	39	10	23.1
Highest	9	0	0.0
Sexual partners			
0-1	185	32	16.1
2+	10	5	52.1
Number of pregnancies			
1-2	84	20	24.2
3+	111	17	14.0
ARV use at pregnancy			
Yes	120	9	6.8
No	75	28	36.8
Alcohol use			
Yes	186	35	18.4
No	9	2	14.8
Woman status			
Pregnant	73	19	23.9
Lactating	122	18	15.0

3.4 Factors associated with viral load non-suppression

In statistical analysis, we used robust logistic regression which incorporated both survey weights and clustering and initially determined the association of each individual risk factor with the outcome variable. We then included all risk factors with a p-value of less than 0.2 from the crude analysis in the multivariable logistic regression model. Factors with an adjusted p-value less than 0.1 were kept in the final model. Significant factors at multivariable analysis are bolded with their respective OR, CI and p-values.

In an unadjusted analysis, women aged between 17 to 24 years old were four times more likely to have virological non-suppression (OR=4.1, 95% CI 1.9 – 8.6, $p < 0.001$). Women who were not in union were almost three times more likely to have virological non-suppression (OR=2.7, 95% CI 1.2 – 6.2, $p = 0.015$). Women who reported having two or more sexual partners in the past 12 months were almost six times likely to have virological non-suppression (OR=5.7, 95% CI 1.4 – 22.8, $p = 0.015$). Number of pregnancies were marginally associated with virological non-suppression, with women reporting having three or more pregnancies being twice as likely to have virological non-suppression (OR=2.0, 95% CI 0.9 – 4.1, $p = 0.074$). Women who reported no use of ARVs at last pregnancy or breastfeeding were eight times more likely to have virological non-suppression (OR=7.9, 95% CI 3.3 – 18.9, $p < 0.001$).

In a multivariable analysis, two risk factors remained statistically significant. Women who were aged 17 to 24 years old were almost five times more likely to be virologically non-suppressed (AOR = 4.7, 95% CI 1.8 – 11.8, $p = 0.001$). Women who did not use ARVs during their last pregnancy or breastfeeding period were 8 times likely to be virologically non-suppressed (AOR = 8.1, 95% CI 3.0 – 21.8, $p < 0.001$). Both region and area of residence were included in the final model regardless of their statistical significance. (Table 3). In an additional analysis which included age and location in the final model and excluding the self-reported ARV use at last pregnancy explanatory variable, virological non-suppression was associated significantly with age (OR=5.5, 95% CI 2.3 – 13.7, $p < 0.001$) and having two or more sexual partners in the past twelve months (OR=7.9, 95% CI 1.6 – 40.5, $p=0.013$). (Table 4)

Table 3: *Crude and adjusted factors associated with viral load non-suppression*

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age in years				
17-24	4.1 (1.9 – 8.6)	<0.001	4.7 (1.8 – 11.8)	0.001
25+	Ref		Ref	
Union type				
In union	Ref			
Not in union	2.7 (1.2 – 6.2)	0.015		
Location				
Urban	1.6 (0.6 – 3.6)	0.287	1.3 (0.5 – 3.7)	0.577
Rural	Ref		Ref	
Region				
Hhohho	1.7 (0.6 – 4.5)	0.280	1.6 (0.5 – 4.9)	0.400
Lubombo	Ref		Ref	
Manzini	1.4 (0.5 – 3.9)	0.482	2.5 (0.6 – 10.8)	0.215
Shiselweni	1.0 (0.2 – 3.9)	0.946	1.7 (0.3 – 8.5)	0.544
Education level				
Primary	Ref			
Secondary	1.6 (0.7 – 3.8)	0.260		
Higher	1.1 (0.4 – 3.7)	0.834		
Wealth group				
Lowest	Ref			
Second	1.1 (0.4 – 3.0)	0.876		
Middle	1.1 (0.4 – 3.7)	0.834		
Fourth	1.5 (0.5 – 4.2)	0.466		
Highest	-	-		
Sexual partners				
0-1	Ref			
2+	5.7 (1.4 – 22.8)	0.015		
Number of pregnancies				
1-2	2.0 (0.9 – 4.1)	0.074		
3+	Ref			
ARV use at pregnancy				
Yes	Ref		Ref	
No	7.9 (3.3-18.9)	<0.001	8.1 (3.0 – 21.8)	<0.001
Alcohol use				
Yes	1.3 (0.2-6.9)	0.755		
No	Ref			

As ARV use was self-reported and a considerable number of women who stated they had not taken ARVs but had viral suppression which indicates that they may be unwilling to disclose that they were using ARVs at the time of the interview. It would be helpful to include an extra multivariable model excluding ARV use as an explanatory variable. This to identify other important factors which might have been swamped in the model by ARV use (table 4).

Table 4: *Crude and adjusted factors associated with viral load non-suppression (Excluding ARV use)*

Variable	Crude OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age in years				
17-24	4.1 (1.9 – 8.6)	<0.001	5.5 (2.2 – 13.7)	<0.001
25+	Ref		Ref	
Union type				
In union	Ref			
Not in union	2.7 (1.2 – 6.2)	0.015		
Location				
Urban	1.6 (0.6 – 3.6)	0.287	1.7 (0.6 – 4.7)	0.269
Rural	Ref		Ref	
Region				
Hhohho	1.7 (0.6 – 4.5)	0.280	1.7 (0.5 – 5.0)	0.352
Lubombo	Ref		Ref	
Manzini	1.4 (0.5 – 3.9)	0.482	1.9 (0.6 – 6.6)	0.296
Shiselweni	1.0 (0.2 – 3.9)	0.946	1.0 (0.3 – 3.9)	0.953
Education level				
Primary	Ref			
Secondary	1.6 (0.7 – 3.8)	0.260		
Higher	1.1 (0.4 – 3.7)	0.834		
Wealth group				
Lowest	Ref			
Second	1.2 (0.4 – 3.0)	0.876		
Middle	1.1 (0.4 – 3.7)	0.834		
Fourth	1.5 (0.5 – 4.2)	0.466		
Highest	-	-		
Sexual partners				
0-1	Ref		Ref	
2+	5.7 (1.4 – 22.8)	0.015	7.9 (1.6 – 40.5)	0.013
Number of pregnancies				
1-2	2.0 (0.9 – 4.1)	0.074		
3+	Ref			
Alcohol use				
Yes	1.3 (0.2-6.9)	0.755		
No	Ref			

Chapter Four: Discussion and Recommendations

The aim of this project was to determine the prevalence and assess factors associated with virological non-suppression among pregnant and lactating adult women living with HIV. In the study, we found that the prevalence of virological non-suppression was 18.2% and that factors associated with virological non-suppression were maternal age and ARV use at pregnancy. Further analysis indicated that virological non-suppression was also associated with number of sexual partners in the past twelve months when excluding the self-reported ARV use variable from the analysis.

The primary study was not powered to detect differences in virological non-suppression between two or more groups of interest. The sample size was small, which limited the ability to investigate other possible explanatory variables.

At 18.1%, the overall virologic non-suppression prevalence is higher than that of the UNAIDS milestones by 2020 under the fast-track approach to speed up HIV elimination and also higher than the targets set by the Ministry of Health of Eswatini through the HIV guidelines. Only 62.1% of the women reported using ARVs to prevent MTCT, this was very low noting that the country had started implementing PMTCT B+ in some parts of the country and again below the fast-track targets by UNAIDS (Ministry of Health Eswatini, 2015; UNAIDS, 2020).

In a multivariable analysis, factors associated with virological non-suppression were maternal age and ARV use at pregnancy. A similar study by Megan Landes *et al.* conducted in Malawi found that most women who were not on ARVs had virological non-suppression compared to women who were on ART (Landes *et al.*, 2019). A similar study by Marcel Yotebieng *et al.* in the Democratic Republic of Congo depicted similar findings with a higher proportion of women in the older age group being virally suppressed compared to women in younger age groups, and a higher proportion of participants starting ARVs earlier being virally suppressed compared to those starting ARVs later post HIV diagnosis (Yotebieng *et al.*, 2020). Furthermore, a South African study by Woldesenbet corroborated the findings from this study showing higher rates of virological non-suppression among younger women compared to the older women and virological non-suppression higher in women who were not on ARVs compared to women on ART (Woldesenbet *et al.*, 2020).

High virological non-suppression among women not starting ART at pregnancy is suggestive of a need to strengthen both the ART and PMTCT programs in offering of universal ART regardless of WHO clinical staging and CD4 count. It is worth noting that at the beginning of

the primary study, PMTCT Option A was still standard of care, and this may be indicative of its poor effectiveness. In addition, 63.2% of women who reported not using ARVs were virologically suppressed, which may be due to stigma and choosing not to mention they were on ARVs. They may have feared to disclose their HIV status due to stigma or possibly because PMTCT Option A was still standard of care at the time of the survey. Another factor which might mask this suppression could be the use of pre-exposure prophylaxis to prevent HIV transmission. High virological non-suppression was observed among adolescent girls and young women in the study which may be reflective of HIV knowledge gaps among the group and a need for additional interventions to eliminate ongoing HIV transmission.

In considering the findings of this study, it is important to bear in the mind the following limitations, the original study was not powered to detect differences in virological non-suppression among the study participants. In addition, the small sample size may have limited the number of potential risk factors that we could investigate. The study was conducted when Eswatini was transitioning to PMTCT B+ and not all regions of the country were implementing it as PMTCT Option A was standard of care. Ideally one would expect that all women who are taking ARVs would have virological suppression and all women not taking ARVs would have virological non-suppression. Therefore, some women who are on ARVs would not report this since they do not want to disclose that they are HIV-infected due to stigma. As some women were still on PMTCT Option A, it could have impacted the results in two ways, (a) despite taking PMTCT Option A some women may not have achieved virological suppression or (b) some women on option A might not consider this as being on ARVs but might still achieve virological suppression.

Also, the study employed a cross sectional design and viral load was measured at one point in time which may not be representative of the women's viral load burden throughout pregnancy or breastfeeding.

In conclusion, to help the country address the identified gaps, I would recommend the scale up of the Determined, Resilient, Empowerment, AIDS-free, Mentored and Safe (DREAMS) programs to enhance the livelihoods of the adolescent girls and young women. DREAMS provides a core intervention to address key factors that make adolescent girls and young women vulnerable to HIV. Noting that this age group may be more vulnerable to contracting HIV, they need to be purposefully targeted with HIV prevention services and sexual reproductive health education either at school or have it integrated within the DREAMS program.

Noting that virological non-suppression was associated with no ARV use at pregnancy and that PMTCT B+ and test and treat is already standard of care in the country, I would recommend strictly following the HIV guidelines on viral load monitoring to actively track viral load suppression among pregnant and breast-feeding women. As the sample size was small and the country has now transitioned to a patient level electronic medical records system, I would recommend development of central dashboards which clinicians can use to actively track patients due for viral load testing and patients with virological non-suppression for better patient management which could lower the population viral load which would reduce vertical transmission of HIV. Furthermore, well powered national surveys may be needed to assess viral load suppression for more definitive results.

References

- Boeke, C.E. *et al.* (2021) 'Evaluation of near point-of-care viral load implementation in public health facilities across seven countries in sub-Saharan Africa', *Journal of the International AIDS Society*, 24(1), pp. 1–9. Available at: <https://doi.org/10.1002/jia2.25663>.
- Bulage, L. *et al.* (2017) 'Factors Associated with Virological Non-suppression among HIV-Positive Patients on Antiretroviral Therapy in Uganda, August 2014-July 2015', *BMC Infectious Diseases*, 17(1), pp. 1–11. Available at: <https://doi.org/10.1186/s12879-017-2428-3>.
- Chagomerana, M.B. *et al.* (2018) 'Prevalence of antiretroviral therapy treatment failure among HIV-infected pregnant women at first antenatal care: PMTCT option b+ in Malawi', *PLoS ONE*, 13(12), pp. 1–12. Available at: <https://doi.org/10.1371/journal.pone.0209052>.
- Chetty, T. *et al.* (2016) 'Cohort profile: the Hlabisa pregnancy cohort, KwaZulu-Natal, South Africa', *BMJ Open*, 6(10), p. e012088. Available at: <https://doi.org/10.1136/bmjopen-2016-012088>.
- Demissie, D.B. *et al.* (2020) 'Evaluation of Antiretroviral Therapy Initiated Among Pregnant Women Under Option B+ by Viral Load and CD4 Count Outcomes in Selected Hospitals of West Shewa Zone, Oromia Region, Ethiopia', *HIV/AIDS - Research and Palliative Care*, Volume 12, pp. 127–134. Available at: <https://doi.org/10.2147/HIV.S242320>.
- Desta, A.A. *et al.* (2020) 'HIV virological non-suppression and factors associated with non-suppression among adolescents and adults on antiretroviral therapy in northern Ethiopia: A retrospective study', *BMC Infectious Diseases*, 20(1), pp. 1–10. Available at: <https://doi.org/10.1186/s12879-019-4732-6>.
- El-khatib, Z. *et al.* (2011) 'Adherence and virologic suppression during the first 24 weeks on antiretroviral therapy among women in Johannesburg, South Africa - a prospective cohort study', *BMC Public Health*, 11(1), p. 88. Available at: <https://doi.org/10.1186/1471-2458-11-88>.
- Esber, A. *et al.* (2022) 'Temporal trends in self-reported HIV stigma and association with adherence and viral suppression in the African Cohort Study', *AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV*, 34(1), pp. 78–85. Available at: <https://doi.org/10.1080/09540121.2021.1984380>.
- Estill, J. *et al.* (2013) 'Monitoring of Antiretroviral Therapy and Mortality in HIV Programmes in Malawi, South Africa and Zambia: Mathematical Modelling Study', *PLoS ONE*. Edited by A. Barrat, 8(2), p. e57611. Available at: <https://doi.org/10.1371/journal.pone.0057611>.
- Gill, M.M. *et al.* (2016) 'Detectable viral load in late pregnancy among women in the Rwanda option B+ PMTCT program: Enrollment results from the Kabeho Study', *PLoS ONE*, 11(12), pp. 1–14. Available at: <https://doi.org/10.1371/journal.pone.0168671>.

Gourlay, A. *et al.* (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*, pp. 1–21.

Hunt, G.M. *et al.* (2019) 'Prevalence of HIV-1 drug resistance amongst newly diagnosed HIV-infected infants age 4–8 weeks, enrolled in three nationally representative PMTCT effectiveness surveys, South Africa: 2010, 2011–12 and 2012–13', *BMC Infectious Diseases*, 19(S1), p. 787. Available at: <https://doi.org/10.1186/s12879-019-4339-y>.

Kabami, J. *et al.* (2020) 'Population-level viral suppression among pregnant and postpartum women in a universal test and treat trial', *AIDS*, 34(9), pp. 1407–1415. Available at: <https://doi.org/10.1097/QAD.0000000000002564>.

Kahungu, M.M. *et al.* (2018) 'Factors associated with HIV positive sero-status among exposed infants attending care at health facilities: a cross sectional study in rural Uganda', *BMC Public Health*, 18(1), p. 139. Available at: <https://doi.org/10.1186/s12889-018-5024-6>.

Kityo, C. *et al.* (2017) 'HIV Drug Resistance Mutations in Non-B Subtypes After Prolonged Virological Failure on NNRTI-Based First-Line Regimens in Sub-Saharan Africa', *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 75(2), pp. e45–e54. Available at: <https://doi.org/10.1097/QAI.0000000000001285>.

Landes, M. *et al.* (2019) 'Low detectable postpartum viral load is associated with HIV transmission in Malawi's prevention of mother-to-child transmission programme', *Journal of the International AIDS Society*, 22(6). Available at: <https://doi.org/10.1002/jia2.25290>.

Lesosky, M. *et al.* (2020) 'Comparison of guidelines for HIV viral load monitoring among pregnant and breastfeeding women in sub-Saharan Africa', *AIDS*, 34(2), pp. 311–315. Available at: <https://doi.org/10.1097/QAD.0000000000002400>.

Liotta, G. *et al.* (2015) 'Elimination of Mother-To-Child Transmission of HIV Infection: The Drug Resource Enhancement against AIDS and Malnutrition Model', *International Journal of Environmental Research and Public Health*, 12(10), pp. 13224–13239. Available at: <https://doi.org/10.3390/ijerph121013224>.

Medecins Sans Frontieres (2020) *Prevention of mother-to-child transmission of HIV - Protocol - 2020 edition*.

Ministry of Health Eswatini (2015) *Swaziland integrated HIV guidelines 2015*. Mbabane.

Ministry of Health Eswatini (2019) *Swaziland HIV Incidence Measurement Survey 2, Key Findings*. Mbabane.

Mogosetsi, N.J., Mabuza, L.H. and Ogunbanjo, G.A. (2018) 'The Prevalence of HIV Load Suppression and Related Factors Among Patients on ART at Phedisong 4 Clinic, Pretoria, South Africa', *The Open Public Health Journal*, 11(1), pp. 135–146. Available at: <https://doi.org/10.2174/1874944501811010135>.

Mwangi, A. and van Wyk, B. (2021) 'Factors Associated with Viral Suppression Among Adolescents on Antiretroviral Therapy in Homa Bay County, Kenya: A Retrospective Cross-Sectional Study', *HIV/AIDS - Research and Palliative Care*, Volume 13(March), pp. 1111–1118. Available at: <https://doi.org/10.2147/HIV.S345731>.

Myer, L. *et al.* (2017) 'Pregnant and breastfeeding women: A priority population for HIV viral load monitoring', *PLoS ONE*, 14(8), pp. 1–7. Available at: <https://doi.org/10.1371/journal.pmed.1002375>.

Napyo, A. *et al.* (2020) 'Detectable HIV-RNA Viral Load Among HIV-Infected Pregnant Women on Treatment in Northern Uganda', *International Journal of Maternal and Child Health and AIDS (IJMA)*, 9(2), pp. 232–241. Available at: <https://doi.org/10.21106/ijma.374>.

Ngowi, K.M. *et al.* (2022) 'Predicting viral load suppression by self-reported adherence, pharmacy refill counts and real time medication monitoring among people living with HIV in Tanzania', *AIDS Research and Therapy*, 19(1), p. 51. Available at: <https://doi.org/10.1186/s12981-022-00475-y>.

Ntlantsana, V., Hift, R.J. and Mphatswe, W.P. (2019) 'HIV viraemia during pregnancy in women receiving preconception antiretroviral therapy in KwaDukuza, KwaZulu-Natal', *Southern African Journal of HIV Medicine*, 20(1). Available at: <https://doi.org/10.4102/sajhivmed.v20i1.847>.

Nyoni, T. *et al.* (2020) 'The effectiveness of treatment supporter interventions in antiretroviral treatment adherence in sub-Saharan Africa: a systematic review and meta-Analysis', *AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV*, 32(sup2), pp. 214–227. Available at: <https://doi.org/10.1080/09540121.2020.1742870>.

Odeny, T.A. *et al.* (2018) 'Maximizing adherence and retention for women living with HIV and their infants in Kenya (MOTIVATE! study): study protocol for a randomized controlled trial', *Trials*, 19(1), p. 77. Available at: <https://doi.org/10.1186/s13063-018-2464-3>.

Pellowski, J. *et al.* (2019) 'Implementation of prevention of mother-to-child transmission (PMTCT) in South Africa: outcomes from a population-based birth cohort study in Paarl, Western Cape', *BMJ Open*, 9(12), p. e033259. Available at: <https://doi.org/10.1136/bmjopen-2019-033259>.

UNAIDS (2020) *Fast-Track Targets*. GENEVA.

UNICEF *et al.* (2021) *Prevention of mother-to-child transmission of HIV, hepatitis B and C and syphilis*. Vienna.

Villa, G. *et al.* (2020) 'Determining virological suppression and resuppression by point-of-care viral load testing in a HIV care setting in sub-Saharan Africa', *EClinicalMedicine*, 18, p. 100231. Available at: <https://doi.org/10.1016/j.eclinm.2019.12.001>.

Woldesenbet, S.A. *et al.* (2020) 'Viral suppression and factors associated with failure to achieve viral suppression among pregnant women in South Africa', *AIDS*, 34(4), pp. 589–597. Available at: <https://doi.org/10.1097/QAD.0000000000002457>.

World Health Organization (2015) *Guideline on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV*, 2015.

World Health Organization (2017) *Global guidance on criteria and processes for validation: elimination of mother to child transmission of HIV and syphilis, second edition*. Available at: <https://doi.org/10.1177/0897190003016003006>.

World Health Organization (2019) *WHO | Mother-to-child transmission of HIV*, WHO. Geneva: World Health Organization. Available at: <http://www.who.int/hiv/topics/mtct/about/en/> (Accessed: 3 July 2020).

Yotebieng, M. *et al.* (2020) 'HIV viral suppression among pregnant and breastfeeding women in routine care in the Kinshasa province: a baseline evaluation of participants in CQI-PMTCT study', *Journal of the International AIDS Society*, pp. 1–12. Available at: <https://doi.org/10.1002/jia2.25376>.

Appendices

 UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	
R49 Mr M Ndiangamandla	
HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) CLEARANCE CERTIFICATE NO. M210829	
NAME: (Principal Investigator)	Mr M Ndiangamandla
DEPARTMENT:	School of Public Health Division of Epidemiology and Biostatistics Medical School University
PROJECT TITLE:	<i>Prevalence and factors associated with virological non-suppression amongst HIV positive pregnant and lactating adult women in the Kingdom of Eswatini in 2016-2017</i>
DATE CONSIDERED:	2021/08/27
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Professor J Levin
APPROVED BY:	 Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2022/06/29
This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.	

SES Calculation methodology file



Methodology%20F
or%20Estimation%20