FACTORS ASSOCIATED WITH VIRAL SUPPRESSION AMONG ADOLESCENTS ON ANTIRETROVIRAL THERAPY IN HOMABAY COUNTY, KENYA

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A mini-thesis submitted in partial fulfillment of the requirements for the degree of Master in Public Health at the School of Public Health, University of the Western Cape

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KEY WORDS

HIV

AIDS

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Adherence Treatment outcomes

Viral suppression

CD4 Count

Viral load

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Virological failure

Opportunistic infection

ABSTRACT

Background

Globally, it is estimated that about 1.8 million adolescents (aged 10–19 years) were living with HIV in 2015. In Kenya an estimated 133,455 adolescents were living with HIV in 2015, of which 75% (105,679) were in need of antiretroviral therapy (ART). Among adolescents on ART in 2016, 63% reported viral suppression; which is far below the UNAIDS targets of 90%. Viral suppression (having less than 1000 copies of viral RNA/ml of blood) is a key indicator of HIV treatment success, and is associated with better quality of life and reductions in HIV incidence at a population level.

Homabay County recorded the highest HIV prevalence (26%) and the highest number of adolescents living with HIV in Kenya (15,323) in 2015. By the end of June 2017 5,709 adolescents were initiated on ART in Homabay County. Despite the successes in initiating HIV positive adolescents on ART, little is known about the factors that are associated with viral suppression. The current study investigated the factors associated with viral suppression among adolescents initiated on ART before November 30, 2017 in Homabay County, Kenya.

Methods

A descriptive cross-sectional study was conducted among 925 adolescents registered on ART for at least 6 months and with at least one documented viral load in the last 12 months, in six health facilities in Homabay County. Data was extracted from the electronic medical records and exported into an excel spreadsheet. Bivariate and multivariate logistic regression analyses were conducted to identify factors associated to viral suppression using Stata 12.0.

Results

Eighty per cent (737) of the adolescents on ART in participating health facilities in Homabay County had achieved viral suppression as at end of 2017. In bivariate analysis level, those with good adherence to ART (crude OR = 2.72, 95% CI = 1.85– 4.00) and current CD4 count above 500 cells/mm^3 (crude OR = 2.00 [1.23– 4.49]) were more likely to be virally suppressed. Those who were initiated on ART between the ages of 5-9 years (OR crude = 0.53 [0.36–0.80]) and 10-14 years (OR crude = 0.62 [0.39–0.98]) were less likely to be virally suppressed. Additionally those currently on second line ART regimen (OR crude = 0.34 [0.22–0.51]) were also less likely to be virally suppressed.

In the multivariate analysis, good adherence to ART (adjusted odds ratio [AOR] = 2.3, [1.38–3.84]) and CD4 count above 500 cells/mm^3. (AOR = 1.87 [1.13– 3.08]) were significantly associated with viral suppression. Being on second line treatment (AOR = 0.45 [0.28–0.73]) and having inadequate adherence to ART (AOR = 0.26 [0.11–63]) were associated with reduced odds of viral suppression.

Conclusions

Viral suppression among adolescents on ART in the study in Homabay County has significantly improved over time, but it is still below the target of 90%. Adherence support for adolescents on ART is critical for viral suppression, particularly, those who were initiated on ART in pre adolescence and early adolescence. Specific interventions are needed to "rescue" adolescents on 2nd line ART regimens to achieve viral suppression.

DECLARATION

I declare that *Factors associated with Viral Suppression among Adolescents on Antiretroviral Therapy in Homabay County, Kenya* is my work, has not been submitted for any degree or examination at any other university, and that all the sources I have used have been indicated in text and acknowledged in the references section.

Full Name: Dr Anne Wangechi Mwangi

Date: 8 March 2019

Signature

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURE

ABBREVIATIONS AND ACRONYMS

ART	Antiretroviral Therapy
EMR	Electronic medical record
KAIS	Kenya AIDS Indicator Survey
MOH	Ministry of Health
PMTCT	Prevention of Mother to Child Transmission
UNAIDS	Joint United Nations Programme on HIV and AIDS
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Background

There is a growing population of adolescents (aged 10–19 years) living with HIV globally; which is estimated at 1.8 million in 2015 (UNAIDS, 2016). According to the Kenya HIV Estimates (MOH, 2015), about 133,455 adolescents are living with HIV in Kenya. In the last decade Kenya's HIV programme has experienced a rapid scale-up of HIV testing and initiating infants, children and adults on antiretroviral therapy (ART). This has necessitated a stringent monitoring system for those in HIV care and treatment to monitor the effectiveness of the programme.

In 2014, the Joint United Nations Programme on HIV/AIDS (UNAIDS) set new targets towards elimination of HIV, including diagnosis of 90% of HIV infected individuals, access to treatment for 90% of identified HIV infected persons, and 90% viral suppression among those initiated on treatment (UNAIDS, 2014). In 2015, Kenya adopted the UNAIDS targets and also rolled out routine viral load testing as the gold standard to monitor treatment outcomes of ART (WHO, 2013).

Viral suppression among patients enrolled on ART is important for timely detection of treatment failures, and identification of patients who need enhanced adherence counseling (WHO, 2016). According to the Kenyan national guidelines, viral suppression is defined as viral load below 1,000 copies/ml[3] after at least 6 months of using ART (MOH, 2016).
Effective ART leads to viral suppression, which in turn, restores immune function, reduces HIV-related morbidity, prolongs survival, and improves quality of life of HIV patients and also prevents transmission of HIV to their uninfected sexual partners (Cohen *et al.*, 2013; WHO, 2016). Virologic failure occurs when antiretroviral therapy (ART) fails to suppress and sustain a person's viral load to less than 1000 copies/ml (MOH, 2016).

High levels of adherence to ART are needed to ensure viral suppression and prevention of the emergence of HIV drug resistant virus (Paterson et al., 2000). It is widely reported that adolescents find consistent, long-term adherence to any medication difficult, and ART is no exception (Hanghøj & Boisen 2014). Compared to adults, adolescents on ART are more likely to have an unsuppressed viral load and more likely to fail virologically, as reported by two

South African studies (Evans *et al.*, 2013; Nglazi *et al.*, 2012). Another study in Uganda found that children (0-18 years) are almost twice as likely to have virological failure compared to adults (Kamya *et al.*, 2007).

According to the 2016 edition of guidelines on the use of antiretroviral drugs for treating and preventing HIV infection in Kenya, a viral load test should be carried out at 6 and 12 months after initiation of ART and annually thereafter if the viral load is less than 1,000 copies/ml (MOH, 2016). In the same guidelines; treatment failure is defined as a persistently high viral load greater than 1,000 copies/ml (two viral loads measured within a 3-month interval with adherence support between measurements), after at least 6 months of using ART (MOH, 2016). As per WHO clinical treatment guidelines, those with treatment failure should be switched to appropriate second-line or third-line ART regimen, after enhanced adherence counselling (WHO, 2013).

1.2 Research Problem

According to the Kenya national viral load dashboard, the proportion of adolescents achieving viral suppression country-wide is 63%; which is lower than the UNAIDS recommended target of 90% (MOH, 2016). Despite the successes in initiating HIV positive adolescents on ART, little is known about the factors that are associated with viral suppression – which is a key indicator of HIV treatment success. Routinely collected data does not provide reports for adolescents who have achieved viral suppression due to the design of the routine facility data tools which is not disaggregated by age and sex. From literature it is known that WHO stage at ART initiation, the ART regimen, past exposure to nevirapine, gender, age, adherence levels, disclosure of HIV status, having an active opportunistic infection and the quality of clinical care at the health facility are associated with viral suppression in adults (WHO,2013). In addition to analyzing treatment outcomes for adolescents on ART, it is also essential to identify the risk (and protective) factors that influence these outcomes, to assess the success of the ART programme.

1.3 Outline of mini-thesis

Chapter 2: Explores the literature on factors associated with viral suppression among adolescents in sub Saharan Africa and in other parts of the world. There is limited literature available on factors associated with viral suppression among adolescents.

Chapter 3: Describes the methodology of the study. It depicts a clear aim of the study; to determine factors associated with viral suppression among adolescents on ART in Homabay County, Kenya. The objectives, design, data collection and analysis methods of the study are described. This section details a cross-sectional descriptive study of adolescents using data extracted from electronic medical records.

Chapter 4: The study results are presented. An analysis of the results is made to present them with statistical parameters to allow interpretations, inferences and conclusions to be drawn.

Chapter 5: Presents a brief discussion of the results making relevance to related studies with similar topics.

Chapter 6: The conclusion and the study recommendations are drawn from the research findings.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Viral load testing is recommended for monitoring patient's response to ART and to diagnose and confirm treatment failure in patients on antiretroviral therapy (WHO, 2013). A patient's pre-ART viral load level and the magnitude of viral load decline after initiation of ART provide prognostic information about the probability of disease progression (Murray *et al.*, 1999). The key goal of ART is to achieve and maintain durable viral suppression. Unfortunately among adolescents and youth viral suppression is generally suboptimal compared to adults (Joseph Davey *et al*., 2018; Wood *et al.,* 2017). In a study conducted in Namibia, viral suppression rate was lowest among 15-19-year-olds at 68% (Agolory *et al.*, 2018). Several studies conducted in Africa and other parts of the world have attempted to explain the low viral suppression among children and adolescents. These factors include socio-demographic characteristics (age and gender), clinical factors (CD4 count, WHO clinical stage, opportunistic infection), treatment factors (ART regimen, duration of treatment) and behavioural factors that may influence viral suppression among adolescents (Muri *et al.*, 2016; Kamya *et al*., 2007).

2.2 Socio-demographic characteristics

Socio-demographic characteristics such as age at ART initiation and gender of the adolescent have been reported to be associated with viral suppression. Younger age below 10 years at ART initiation was associated with higher virological failure rates in Zimbabwe (Makadzange *et al*., 2015). Similarly Muri *et al*. (2016) associated older age at ART initiation with viral suppression in a study conducted in Tanzania. In contrary, virological failure was higher among adolescents aged 10-16 years at ART initiation compared to children aged 3-9 years at ART initiation in Thailand. (Bunupuradah *et al*., 2015). The three studies present conflicting findings in regard to age at ART initiation; two studies associated older age at ART initiation with viral suppression and one study associated older age with virological failure.

The studies present conflicting reports on the observed associations between gender/sex and viral suppression. A study in Swaziland showed no association of gender and viral suppression (Jobanputra et al., 2015), while Muri *et al*. (2016) found significantly higher rates of virological failure among female adolescents in their study in Tanzania. In contrast, studies in Malawi, South Africa and Uganda found that male gender was independently associated with virological non-suppression (Umar *et al.,* 2018; Joseph Davey *et al.,* 2018; Kamya *et al.,* 2007).

Similarly, Kipp *et al.* (2010) in his study, found a significant association between female gender and viral suppression six months after ART initiation.

2.3 Clinical factors

The clinical factors of significance in treatment outcomes for ART are baseline CD4 count, WHO clinical stage at ART initiation, and presence of opportunistic infections (Ayele *et al.*, 2015). In Tanzania it was reported that adolescents that had a high CD4 cell count at ART initiation was associated with better viral suppression 12 months after ART initiation (Muri *et al.*, 2016). A high CD4 cell count gives indicates a health immune system and hence better response upon starting ART.

The WHO clinical stages are categorized as 1 through 4, progressing from primary HIV infection to advanced HIV/AIDS. Previously, WHO staging system was used in many countries to determine eligibility for antiretroviral therapy (WHO, 2010). Having advanced clinical disease or WHO clinical stage 4 condition at the time of initiation of ART was associated with virological failure in adult patients in Vietnam (Huong *et al.,* 2011). Advanced HIV disease or WHO stage 4 is associated with poor immunological response upon initiation of ART and increased likelihood of virological failure.

Having an active opportunistic infection like tuberculosis (TB) was associated with low viral suppression across all age categories in Uganda (Bulage *et al.*, 2017). In particular, in South Africa, patients on TB treatment had an unsuppressed viral load (Joseph Davey *et al.,* 2018).

2.4 Treatment factors

Treatment factors are all factors relating to ART regimen, such as prior treatment using nevirapine (NVP) type of ART regimen at initiation of treatment and timeliness in switching to effective ART regimens after failure. For a number of years, NVP has for a long time been used routinely as a first line ART regimen in Kenya. This includes its use by the mother or extended NVP for infants for prevention of mother to child transmission (PMTCT). Unfortunately NVP being a non-nucleoside reverse transcriptase inhibitor (NNRTIs) has low genetic barrier with increased risk of development of mutations and drug resistance and virological failure. Being on a NNRTI or a NVP based ART regimen has been associated with increased risk of virological failure (Muri *et al.,* 2016; Makadzange *et al,* 2015; Bunupuradah

et al., 2015). Past exposure to NVP for PMTCT in infancy significantly increases the risk of NVP resistance (Fogel *et al.*, 2013; Nelson *et al.,* 2015; Duong *et al.*, 2014). Children on NVP without previous exposure to NVP developed virologic failure during the first year of ART (Chohan *et al.,* 2015). On the other hand, Bain-Brickley *et al.* (2011) and Muri *et al. (*2016) demonstrated that adolescents on lopinavir/ritonavir (LPV/r) containing regimen had better viral suppression. Likewise, patients who were switched to second/third line regimen had low risk of virological non-suppression (Bulage *et al.*, 2017).

The timeliness in switching to effective ART regimens after failure may also affect viral suppression. Children and adolescents with delayed switching from a failing ART regimen to an effective one, experience virological failure and are at an increased risk of accumulating drug resistance and mutations, resulting in fewer choices of active ARVs and a poor response to the new therapy (Salou *et al.,* 2016). In a study conducted in South Africa, Bernheimer *et al.* (2015 concluded that a large number of children do not achieve viral suppression due to low rate of regimen changes despite failure on first-line regimen.

2.5 Behavioural and Social factors

Good adherence to the ART is crucial for successful viral suppression; incomplete adherence on the other hand leads to an increase in HIV viremia, risk of treatment failure, and accumulating resistance mutations (Li *et al.,* 2014). Studies have demonstrated that suboptimal adherence to ART is associated with virological failure in children and adolescents (Muri *et al.*, 2016). In Ethiopia, non-adherence to medications was associated with high viral load of ≥1000 copies/ml (Hailu *et al*., 2018). In a study describing predictors of antiretroviral treatment adherence among a diverse cohort of adolescent's in the United States of America, nonadherence by self-report was associated with higher viral load (Chandwani *et al.,* 2012). Abreu *et al.* (2017) and Bulage *et al.* (2017) in different studies demonstrated that poor adherence to ART was associated with low viral suppression. Patients achieving full adherence over 12-month period were significantly more likely to exhibit virological suppression (Nachega *et al.,* 2009). In a one to one unmatched case control study conducted in Zimbabwe, poor adherence among others was an independent risk factor for virological failure (Sithole *et al.,* 2018). Several studies that explored the factors that affect the adolescent's adherence to ART indicate behavioural factors such as alcohol consumption and psychological factors such a stigma and social support may affect adherence and viral suppression.

The social structures such as support from family, the peers and the community at large also influence adherence and hence HIV viral suppression with maternal and paternal orphans being at increased risk of poor adherence to ART (Fokam *et al.,* 2017). In a systematic review, non-randomised trial of peer support group therapy for adolescents demonstrated no change in self-reported adherence, but reported increase in the percentage of participants with suppressed viral load (Bain-Brickley *et al.,* 2011). A multicentre cohort study in South Africa demonstrated improved viral suppression in children under 16 years on ART receiving community-based adherence support (Fatti *et al*., 2014). While social stigma was associated with virological non suppression in Malawi (Umar *et al.,* 2018), social support, self-efficacy, emotional support and counselling from peer group were reported to be as strong adherence-promoting factors (Xu *et al.,* 2017; Umar *et al*., 2018).

Disclosure is another factor considered to influence the adolescent's adherence to ART. Bernheimer (2015) observed that delayed disclosure affected adherence and viral suppression in pre-adolescent and adolescent patients. A qualitative study conducted in Uganda had similar findings where delays in disclosing HIV status to perinatally infected children prior to adolescence were common and leading to non-adherence (Inzaule *et al.*, 2016). In Zimbabwe, non-disclosure increased the odds of virological failure (Sithole *et al.,* 2018) and in Nigeria disclosure of HIV status predicted a better adherence to ART (Ugwu & Eneh, 2013). On the contrary fear of disclosing HIV status to others, especially boy/girlfriends, were important contributors to suboptimal adherence (Xu *et al.*, 2017).

Other behavioural factors that may affect adherence to ART include alcohol use by the care givers or the adolescents, in one study non-use of alcohol and lower caregiver scores for anxiety were associated with better adherence and viral suppression in their children and adolescents (Cruz *et al.,* 2014). One case control study conducted in Zimbabwe alcohol consumption by the adolescent increased the odds of virological failure (Sithole *et al.,* 2018).

Most studies reviewed focused on viral suppression among adults and/or children with few studies looking at viral suppression among adolescents. This study will add to the literature on the factors affecting viral suppression among adolescents.

2.6 Summary of literature review

There was limited literature on factors affecting viral suppression among adolescents, this extensive review of literature demonstrates that most studies have been conducted among adults and children. In summary, the reviewed studies presented conflicting findings on the observed associations between age and gender and viral suppression. Some of the studies associated current age, gender and age at ART initiation of the adolescent with viral suppression while others found no association or associated the demographic factors with virological failure. In regard to the clinical factors all the reviewed studies associated low baseline CD4 count and advanced WHO stage at ART initiation with virological failure. Two studies in Uganda and South Africa associated active TB with virological failure and high viral load.

In the review of treatment factors, prior exposure to nevirapine as an ART regimen or for PMTCT was associated with virological failure in the reviewed studies. On the contrary adolescents on protease inhibitor based regimens had better viral suppression.

Finally all the reviewed studies associated good adherence to ART with viral suppression, similarly virological failure and high viral loads were associated with sub optimal adherence and non-adherence. Non-disclosure of HIV status or late disclosure affected adherence to ART leading to virological failure while early disclosure was associated with better adherence and viral suppression.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This section describes the methodology of the study. It depicts clearly the aim of the study which was to determine factors associated with viral suppression among adolescents on ART in Homabay County, Kenya. It also outlines the study objectives, describes the study settings, design, study population and sampling, data collection and analysis. In this section validity and reliability as well as generalizability of the study are described.

The ethics considerations that were put in place are also detailed in the methodology section. In general this section details a cross-sectional descriptive study of adolescents using data extracted from electronic medical records.

3.1 Aim and Objectives

The aim of the study was to determine factors associated with viral suppression among adolescents on ART before November 30, 2017 in Homabay County, Kenya.

The objectives of the study were:

- To describe viral suppression amongst adolescents who had been on antiretroviral therapy for at least 6 months.
- To determine the sociodemographic characteristics associated with viral suppression.
- To determine clinical factors associated with viral suppression.
- To determine treatment factors associated with viral suppression amongst adolescents.
- To determine behavioral factors that are associated with viral suppression among adolescents.

3.2 Description of study setting

Homabay County is one of 47 counties of Kenya located in the South Nyanza region, bordering Lake Victoria. The county bears the largest burden of HIV in the country with an adult prevalence of 26%, compared to the national average of 6% (KAIS, 2014). The county has an estimated 15,323 adolescents living with HIV, with 2,945 new HIV infections and 238 HIV-related deaths annually (MOH, 2015). The study was be conducted in Homabay county referral

hospital and five sub-county hospitals that are using electronic medical records for patient management. About 1,100 adolescents were on ART in the 6 hospitals.

3.3 Study design

A descriptive cross-sectional study design, using routinely collected programme data extracted from the electronic medical records (EMR) was used. A total of 925 adolescents on ART for at least 6 months with at least one documented viral load in the last 12 months were included in the study.

3.4 Study population and sampling

The study population constituted all adolescents, aged 10-19 years, who were receiving ART in six hospitals in Homabay County. The hospitals were selected for the study because they had a high volume of patient and hence a higher number of adolescents on ART, and were using electronic medical records (EMR) for patient management.

All the adolescents who met the selection criteria indicated below were included in the study sample.

Inclusion criteria

- Adolescents on antiretroviral therapy for at least 6 months.
- Those who have at least one documented viral load in the last 12 months.

Exclusion criteria

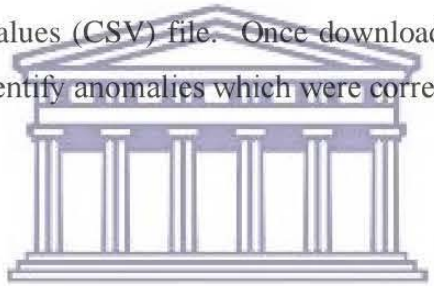
- Those transferred in from another health facility within the last 6 months.
- Those who have transferred out to another facility more than 12 months prior to the start of the study.

The Kenya guidelines for ART prescribe viral load testing 6 months after ART initiation and the second viral load 12 months after ART initiation. Recruiting adolescents who have been on ART for at least 6 months ensured that they had at least one viral load.

3.5 Data collection

The principal investigator engaged a research assistant who extracted data from the electronic medical records (EMR). An EMR is a digital version of a paper chart that contains all of a patient's data having been collected directly from the patient or from the medical outpatient file/card (Gunter & Terry 2005). It captures the demographics, medical history, medication, laboratory test results, vital signs, and personal statistics like age and weight. An EMR is used by health care providers for diagnosis and day to day patient care. It eliminates the need to track down a patient's previous paper medical records and assists in ensuring data is accurate and legible. The EMR was reviewed and a list of all adolescents on ART for at least 6 months generated. Of these, only adolescents with recorded viral loads in the last 12 months were included in the study.

Before extracting data from the EMR, the research assistant ran a query for the specific variables of interest in the EMR. The data from the EMR was then downloaded into an excel file or a Comma-Separated Values (CSV) file. Once downloaded in the Excel or CSV file cross-checking was done to identify anomalies which were corrected using the patient's paper files.



3.6 Data analysis

Data from the EMR was downloaded into excel spreadsheet and cleaned. Since the EMR is a secondary data source; pharmacy records, laboratory and the patient's clinic records were used to complete any missing data in the EMR. Values that were missed completely were dropped automatically from each variable and analysis conducted based on the totals with complete records. Data analysis was conducted using Stata 12.0 (Stata Corp. 2011. Stata Statistical Software: Release 12. College Station, TX: Stata Corp LP). Descriptive statistics such a frequencies and medians were used to ascertain the quality of data.

A total of 925 patient records who had a viral load done in the last 12 months were analysed to estimate the proportion of patients with viral suppression, and to identify factors associated with viral suppression. The outcome variable of suppression status was generated by categorizing the viral load results into two groups. All results <1000 copies/ml of blood were categorized as suppressed while ≥1000 copies/ml of blood were categorized as not suppressed.

To describe the socio-demographic and clinical characteristics of the study population a frequency table of characteristics such as adolescent age, sex, age at ART initiation, WHO clinical stage, CD4 count at ART initiation, current CD4 Count, ever had active TB, duration on treatment, antiretroviral regimen at ART Initiation, current ART treatment line, ART adherence, and disclosure was done.

Bivariate analysis was used to determine strengths of association between the independent variables and the outcome variable (viral suppression status). Chi-square tests and Crude Odds ratios were used to test and measure the associations respectively. At 5% significance level, all variables that were significantly associated with viral suppression during bivariate analysis were considered for inclusion in the multivariate analysis. Adjusted odds ratios (AOR), 95% confidence intervals and *p*-values for the final multivariate logistic regression model are presented.

3.7 Validity and Reliability

To minimize selection bias all adolescents in the sampled facilities who meet the inclusion criteria were enrolled for the study. To prevent measurement bias, all patient level data was extracted from the EMR including viral load, CD4 count and other exposure variables.

The County health records and information department conducts quarterly data quality audits on the EMR thereby ensuring that the data is complete, accurate and a true reflection of HIV care services in the county.

Before extracting data from the EMR, the research assistant run a query for the specific variables of interest in the EMR. The data from the EMR was then be downloaded into an excel files or a Comma-Separated Values (CSV) file. Once downloaded in the Excel or CSV file cross-checking was be done to identify anomalies which were corrected using the patient's paper files. Cross validation will ensure correctness and completeness of data before analysis was done.

3.8 Generalisability

The adolescents in this study were presumed to be representative of adolescents across Homabay County; therefore the findings can be generalizable within the county as well as in other high burden counties in the Nyanza region of Kenya with similar HIV epidemic patterns including high incidence and high HIV prevalence among adolescents and many other factors affecting adolescents that may be similar to those in Homabay County.

However, the study may not be generalizable to adolescents in other parts of the country with different HIV prevalence and incidence and living different social, cultural and economic environment.

3.9 Ethics Considerations

The study was conducted upon approval from the Faculty of Community and Health Sciences Higher Degrees Committee, after which ethical clearance was sought from the University of Western Cape Biomedical Research Ethics Committee (BMREC) and the AMREF Kenya Ethics and Scientific Review Committee. Administrative approval was sought from the Ministry of Health Homabay County Health Department. (See appendix 2, 3 and 4.)

Informed consent was not be sought because, the patient level data was extracted from the EMR and direct contact with the patients was not required. Routinely collected data was extracted from patient's records. The excel spread sheets had unique patient and facility identifiers that were used during data extraction from the EMR and analysis. To ensure patient anonymity, no patient names were recorded in any study material. A link between the unique study identifier and the patient's hospital registration number was maintained for any cross referencing during the period of the study. No biological specimens were collected from the adolescents. Only anonymous data with a study number was entered in the database.

The various data drafts were saved in password protected storage devices and are in the possession of the primary researcher.

CHAPTER 4: RESULTS

4.1 Characteristics of the study participants

Table 4.1 describes the characteristics of the adolescents who were included in the study. It provides a description of the baseline demographic and clinical characteristics of the study participants.

4.1.1 Demographic Characteristics of Study Participants

The median age of adolescents in the study was 14.0 years (Interquartile Range [IQR] 12.0 - 16.0). Majority of the adolescents in this study (59%) were aged 10-14 years and female (57.5%).

The median age at ART initiation in the current cohort was 7.0 years (IQR 3.0-10.0). With 33% initiating ART below 4 years of age, 38% at the age of 5-9 years, 23% at the age of 10-14 years and a small proportion (6.5%) at the age of 15-19 years.

4.1.2 Clinical Characteristics of Study Participants

Of those participants who had documented WHO staging done at ART initiation, 60% (440) were classified as WHO stage I or II, and 40% (293) were WHO stage III or IV. Most participants (72.2%) had a CD4 count above 500 cells/mm^3 at ART initiation. Only 4.6% of participants had a history of active TB.

The median duration on treatment ART was 6.5 years (IQR 3.2-9.0); and 39.6% (356) of the adolescents had been on ART for six to ten years, 22.6% (203) for less than two years, 21.6% for three to five years and 16.2% for more than ten years.

Majority of the patients had started ART with a non-nucleoside reverse transcriptase inhibitor (NNRTI) based regimen (97.3%) while 2.7% had started on a protease inhibitor (PI) based regimen. Most participants (73.4%) in the study were currently on first line ART regimen, while 26.6% were currently on a second line ART regimen. Most (93.2%) patients were aware of their HIV status and 73.2% were documented to have good adherence to ART at the last visit.

Table 4.1: Demographic and Clinical Characteristics of the adolescent patients on ART (n=908)

Factor	Characteristic	n (%)
Age Group	10-14 years	537 (59.1%)
	15-19 years	371 (40.9%)
Sex	Female	522 (57.5%)
	Male	386 (42.5%)
Age at ART initiation	0-4 years	302 (33.3%)
	5-9 years	343 (37.8%)
	10-14 years	204 (22.5%)
	15-19 years	59 (6.5%)
Initial WHO Clinical Stage	Stage I or II	440 (60.0%)
	Stage III or IV	293 (40.0%)
CD4 count at ART initiation	<500	252 (27.8%)
	500+	656 (72.2%)
Current CD4 count	< 500	184 (20.3%)
	500+	724 (79.7%)
Ever had active TB	Yes	42 (4.6%)
Duration on treatment	0-2 years	203 (22.6%)
	3-5 years	194 (21.6%)
	6-10 years	356 (39.6%)
	10+ years	146 (16.2%)
Antiretroviral regimen at ART initiation	NNRTI based	874 (97.3%)
	PI based	24 (2.7%)
Current ART treatment line	1st line	477 (73.4%)
	2nd line	173 (26.6%)
ART adherence	Poor	180 (21.1%)
	Inadequate	49 (5.7%)
	Good	626 (73.2%)
Aware of HIV status (disclosed to)	Yes	751 (93.2%)

4.2 Characteristics of adolescents with viral suppression

Table 4.2 summarizes the demographic and clinical characteristics of the adolescents who had achieved viral suppression defined as having <1000 copies of viral RNA/ml of blood, in the study.

4.2.1 Demographic characteristics of adolescents with viral suppression

The median age of suppressed adolescents in the study was 14.0 years (Interquartile Range [IQR] 12.0 - 16.0). Majority of the suppressed adolescents (59.8%) were aged 10-14 years and female (57.7%).

The median age at ART initiation of suppressed adolescents was 7.0 years (IQR 3.0-10.0). More than two-thirds (35.5% and 35.8%) of the adolescents initiated ART at the ages of 0-4 years and 5-9 years respectively; while 22% at 10-14 years and a small proportion (6.6%) had initiated ART at 15-19 years of age.

4.2.2 Clinical Characteristics of adolescents with viral suppression

Of those suppressed adolescents who had documented WHO staging done at ART initiation, 60.3% (347) were WHO stage I or II, while 39.7% (228) were WHO stage III or IV. Most adolescents (72.7%) had a CD4 count above 500 cells/mm^3 at ART initiation. Only 4.8% of the adolescents in the study had ever had active tuberculosis.

The median duration on treatment was 6.7 years (IQR 3.3-9.3); and 40.1% of the adolescents had been on ART for six to ten years, 22.6% for less than two years, 20.4% for 3-5 years and 16.9% for more than 10 years.

Most adolescents had started ART with a non-nucleoside reverse transcriptase inhibitor (NNRTI) based regimen (97.8%) and 2.2% on a protease inhibitor (PI) based regimen and majority were currently on first line ART regimen (77.7%) while 22.3% were currently on a second line ART regimen.

Most (93.5%) patients were disclosed to about their HIV status and 79.3% were documented to have good adherence to ART at the last visit.

Table 4.2. Demographic and Clinical Characteristics of the Adolescents by Viral suppression n=726

Factor	Characteristic	n (%)
Age Group	10-14 years	434 (59.8%)
	15-19 years	292 (40.2%)
Sex	Female	419 (57.7%)
	Male	307 (42.3%)
Age at ART initiation	0-4 years	258 (35.5%)
	5-9 years	260 (35.8%)
	10-14 years	160 (22.0%)
	15-19 years	48 (6.6%)
Initial WHO Clinical Stage	Stage 1 or II	347 (60.3%)
	Stage III or IV	228 (39.7%)
CD4 count at ART initiation	<500	198 (27.3%)
	500+	528 (72.7%)
Current CD4 Count	< 500	129 (17.8%)
	500+	597 (82.2%)
Ever had active TB	No	691 (95.2%)
	Yes	35 (4.8%)
Duration on treatment	0-2 years	163 (22.6%)
	3-5 years	147 (20.4%)
	6-10 years	289 (40.1%)
	10+ years	122 (16.9%)
Antiretroviral regimen at ART Initiation	NNRTI based	703 (97.8%)
	PI based	16 (2.2%)
Current ART treatment line	1st line	414 (77.7%)
	2nd line	119 (22.3%)
ART adherence	Poor	123 (18.2%)
	Inadequate	17 (2.5%)
	Good	535 (79.3%)
Disclosure	Unaware of HIV status	42 (6.5%)
	Aware of HIV status	604 (93.5%)

4.3 Proportion of Adolescents with viral suppression

Most adolescents 726 (80%) had a suppressed viral load (figure 4.1).

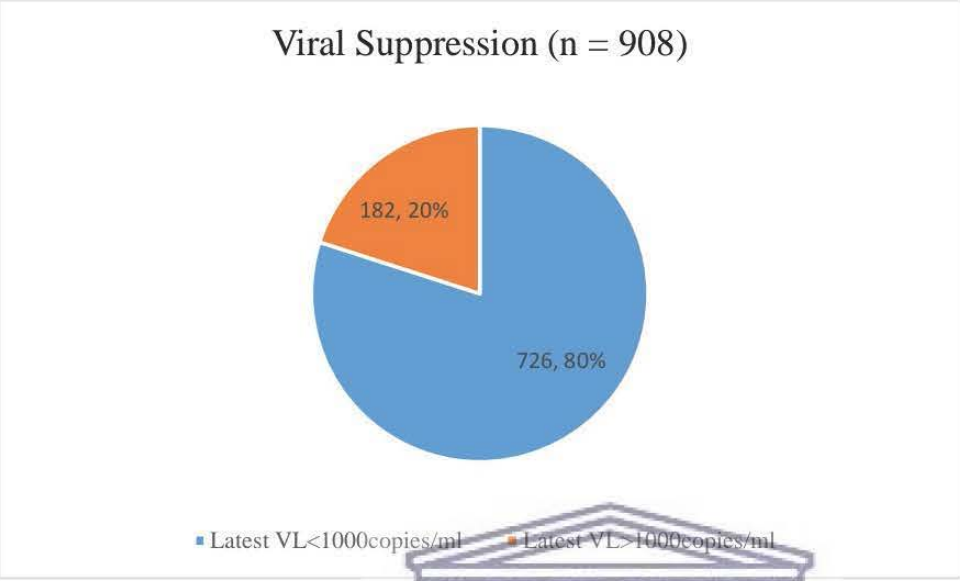


Figure 4.1: Proportion of adolescents with viral suppression

There was no statistically significant differences in viral suppression of participants by age group (10-14 vs 15-19 years: 80.8% vs 78.7%; $p = 0.434$) or gender (female: 80.3% vs male: 79.5%; p=0.785). However, the proportion of supressed adolescents aged 5-9 years (75.8%; p=0.002) and 10-14 years (78.4%; p=0.043) was significantly lower compared to those aged 0-4 years (85.4%) and 15-19 years (81.4%; p=0.427) at ART initiation.

The proportion of suppressed adolescents did not differ by WHO stage at ART initiation (I or II vs III and IV: (78.9% vs 77.8%; p=0.735). Similarly the proportion of suppressed adolescents did not differ by CD4 count at ART initiation (<500 cells/mm^3 vs > 500 cells/mm^3: 78.6% vs 80.5%; p=0.518). However, the proportion of supressed adolescents by current CD4 count differed significantly (CD4 >500 cells/mm^3 vs CD4<500 cells/mm^3: 82.5% vs 70.1%; p=0.01). The proportion of adolescents with current CD4 count equal to or above 500 cells/mm^3 was higher compared to those with CD4 count <500 cells/mm^3.

There was no statistically significant difference in viral suppression of participants by those who ever had active TB and those who did not (83.3% vs 79.8%; $p = 0.576$). Similarly, the proportion with viral suppression did not differ significantly by duration on treatment (0-2 years [80.3%], 3-5 years [75.8%], 6-10 years [81.2%], >10 years [83.6%]). There was also no

statistically significant difference in the proportion of suppressed adolescents by antiretroviral regimen at ART initiation (NNRTI based regimen vs PI based regimen: 80.4% vs 66.7%; p= 0.103).

However, adolescent currently on a first line ART regimen had a higher proportion of suppressed adolescents compared to those on second line ART regimen (86.8% vs 68.8%; p=0.000). There was a high proportion of adolescents with viral suppression amongst those who reported good adherence to ART compared to those with poor or inadequate adherence (p=0.000). The proportion of suppressed adolescents did not differ among adolescents with documented disclosure (awareness of own HIV status and those unaware of their HIV status (80.4% vs 76.4%; p=0.467).

Table 4.3 Characteristics of adolescents with viral suppression

Variable	Characteristic	n (%)	p-value
Age Group	10-14 years	434 (80.8%)	
	15-19 years	292 (78.7%)	0.434
Sex	Female	419 (80.3%)	
	Male	307 (79.5%)	0.785
Age at ART initiation	0-4 years	258 (85.4%)	
	5-9 years	260 (75.8%)	0.002
	10-14 years	160 (78.4%)	0.043
	15-19 years	48 (81.4%)	0.427
Initial WHO Clinical Stage	Stage 1 or II	347 (78.9%)	
	Stage III or IV	228 (77.8%)	0.735
CD4 count at ART initiation	<500	198 (78.6%)	
	500+	528 (80.5%)	0.518
Current CD4 Count	< 500	129 (70.1%)	
	500+	597 (82.5%)	0.01
Ever had active TB	No	691 (79.8%)	
	Yes	35 (83.3%)	0.576
Duration on treatment	0-2 years	163 (80.3%)	
	3-5 years	147 (75.8%)	0.277
	6-10 years	289 (81.2%)	0.798
	10+ years	122 (83.6%)	0.437
Antiretroviral regimen at ART Initiation	NNRTI based	703 (80.4%)	
	PI based	16 (66.7%)	0.103
Current ART treatment line	1st line	447 (86.8%)	
	2nd line	119 (68.8%)	0.000
ART adherence	Poor	123 (68.3%)	
	Inadequate	17 (34.7%)	0.000
	Good	535 (85.5%)	0.000
Disclosure	Unaware of HIV status	42 (76.4%)	
	Aware of HIV status	604 (80.4%)	0.467

4.4 Factors associated with Viral Suppression

Table 4.4 represents data on factors associated with viral suppression by demographic, clinical and treatment characteristics. The results of bivariate analysis and multivariate analysis are presented starting with demographic, clinical, treatment and finally behavioural factors affecting viral suppression in crude and adjusted odds ratios respectively.

4.4.1 Demographic Characteristics and viral suppression

Age group (10-14 vs 15-19 years) and gender were not significantly associated with viral suppression. However, those who initiated ART at the age of 5-9 years (crude odds ratio [OR crude] = 0.53, [95% confidence interval (CI) 0.36–0.80] and 10-14 years (OR crude = 0.62 [0.39–0.98]) were less likely to be virally suppressed compared to those 15-19 years of age (OR crude = 0.74 [0.36–1.54]).

4.4.2 Clinical factors and viral suppression

The WHO stage and CD4 count at ART initiation were not significantly associated with viral suppression (p=0.735 and p=*0.*518). Having ever had tuberculosis was also not significantly associated with viral suppression (p =0.576). However, those with a current CD4 count of >500 cells/mm^3 were more likely to be suppressed compared to those with a current CD4 count below 500 cells/mm^3 (OR crude = 2.00 [1.23– 4.49]; p=0.01).

4.4.3 Treatment factors and viral suppression

Duration on ART was not significantly associated with viral suppression, 3-5 years (p=0.277), 6-10 years (p=0.798), 10+ years (p=0.437). Antiretroviral regimen at ART Initiation (NNRTI or PI based regimen) was also not associated with viral suppression (p=0.103). However, adolescents who are currently on second line ART regiment were less likely to be suppressed (OR crude = 0.34 [0.22–0.51]; p= 0.000).

4.4.4 Behavioural factors and viral suppression

Those with good adherence to ART (OR crude = 2.72 [1.85– 4.00]; p=0.000) were more likely to be virally suppressed, compared to those with inadequate or poor adherence. There was no significant difference in viral suppression among those who were aware of their HIV status and those who were not disclosed to (p=0.467).

4.4.5 Multivariate Analysis

At multivariate analysis level, current CD4 count >500 cells/mm^3 was independently associated with viral suppression (adjusted odds ratio [AOR] = 1.87, [95% confidence interval (CI) 1.13–3.08], p= 0.014). Similarly, documented good adherence to ART was also significantly associated with viral suppression (AOR = 2.3, [1.38– 3.84]; p=0.001), while documented inadequate adherence was significantly associated with reduced viral suppression (AOR = 0.26, [0.11– 0.63]; p=0.003). Similarly, being on second line ART regimen was also independently associated with reduced viral suppression (AOR = 0.45, [0.28– 0.73]; p=0.001).

Table 4.4: Factors associated with Viral Suppression

Factor	Characteristic	n (% viral suppression)	Crude OR (95% CI)	p-value	Adjusted OR* (95% CI)	P-value*
Age Group	10-14 years	434 (80.8%)	1			
	15-19 years	292 (78.7%)	.88 (.63 1.22)	0.434		
Sex	Female	419 (80.3%)	1			
	Male	307 (79.5%)	.96 (.689 1.33)	0.785		
Age at ART initiation	0-4 years	258 (85.4%)	1			
	5-9 years	260 (75.8%)	.53 (.36 .80)	0.002*		
	10-14 years	160 (78.4%)	.62 (.39 .98)	0.043*		
	15-19 years	48 (81.4%)	.74 (.36 1.54)	0.427		
Initial WHO Clinical Stage	Stage 1 or II	347 (78.9%)	1			
	Stage III or IV	228 (77.8%)	.94 (.66 1.35)	0.735		
CD4 count at ART initiation	<500	198 (78.6%)	1			
	500+	528 (80.5%)	1.13 (.79 1.61)	0.518		
Current CD4 Count	< 500	129 (70.1%)	1		1	
	500+	597 (82.5%)	2.00 (1.23 4.49)	0.01*	1.87 (1.13 3.08)	0.014
Ever had active TB	No	691 (79.8%)	1			
	Yes	35 (83.3%)	1.27 (.55 2.90)	0.576		
Duration on treatment	0-2 years	163 (80.3%)	1			
	3-5 years	147 (75.8%)	.77 (.48 1.24)	0.277		
	6-10 years	289 (81.2%)	.06 (.68 1.64)	0.798		
	10+ years	122 (83.6%)	1.75 (.71 2.18)	0.437		
Antiretroviral regimen at ART Initiation	NNRTI based	703 (80.4%)	1			
	PI based	16 (66.7%)	.48 (.20 1.16)	0.103		
Current ART treatment line	1st line	414 (86.8%)	1		1	
	2nd line	119 (68.8%)	.34 (.22 .51)	0.000*	.45 (.28 .73)	0.001
ART adherence	Poor	123 (68.3%)	1		1	
	Inadequate	17 (34.7%)	.25 (.12 .48)	0.000*	.26 (.11 .63)	0.003
	Good	535 (85.5%)	2.72 (1.85 4.00)	0.000*	2.3 (1.38 3.84)	0.001
Disclosure	Unaware of HIV status	42 (76.4%)	1			
	Aware of HIV status	604 (80.4%)	1.23 (.67 2.43)	0.467		

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter presents discussions of the study findings in relation to problem statement and available literature review. The discussions are arranged according to the following sub-sections: proportion of adolescents that attained viral suppression following 6 or more months of ART; socio-demographic, clinical factors, treatment factors and behavioural factors influencing viral suppression among adolescents.

5.2 Adolescents that attained viral suppression following 6 or more months on ART

The study found that 80% of adolescents had achieved a suppressed viral load. This is above the previous county estimate of 63%. The study reveals the overall high proportion of suppressed adolescents with good adherence to ART being the single most important factor associated with viral suppression. This is similar to other studies where good adherence to the ART was crucial for successful viral suppression (Li *et al.*, 2014; Nachega *et al.*, 2009). In studies conducted in Tanzania, Ethiopia, United States of America, Brazil, Uganda and Zimbabwe, sub optimal or non-adherence was associated with high viral load or non-suppression (Muri *et al.*, 2016; Hailu *et al.*, 2018; Chandwani *et al.*, 2012; Abreu *et al.*, 2017; Bulage *et al.*, 2017; Sithole et al., 2018).

In 2016, Kenya launched the test and start guidelines which also put great emphasis on enhanced adherence counselling and support for patients whose viral load result is beyond the threshold, as a result the health care system has given a lot of attention to patients with high viral loads (MOH, 2016). Patients with high viral loads are given three sessions of enhanced adherence counselling (EAC) after which a repeat viral load is done. This could explain the high viral suppression and adherence to ART as the single most important factor associated with viral suppression. Findings suggest that viral suppression is possible among adolescents and the 90% WHO targets can be achieved among adolescents.

5.3 Socio-demographic characteristics associated with viral suppression

In this study, age and gender were not determinants for viral load suppression among the adolescents. Adolescents were categorised as 10-14 years and 15-19 years and the differences in viral suppression in the two age categories was not significant. However, those who initiated ART at ages 5-9 years and 10-14 years were less likely to be virally suppressed. The findings are similar to the study in Thailand where virological failure was higher among adolescents

aged 10-16 years at ART initiation (Bunupuradah *et al.*, 2015), but contradicts Muri *et al.*(2016) and Makadzange *et al.* (2015) who associated older age at ART initiation with viral suppression in their studies in Tanzania and Zimbabwe respectively. In this study, there was also no difference in viral suppression between the male and female adolescents, similar to findings in another study in Swaziland (Jobanputra *et al.,* 2015), but contradicts Muri *et al.* (2016) who associated virological failure with the female gender. In Uganda, Kamya *et al.* (2007) found male gender to be an independent predictor of virological failure while Kipp *et al.* (2010) associated female gender with viral suppression six months after ART initiation.

5.4 Clinical factors associated with viral suppression

The study found that CD4 count at ART initiation was not significantly associated with viral suppression. However, adolescents who had a current CD4 count above 500cells/mm^3 were more likely to be suppressed. This contradicts a study in Tanzania where, having a high CD4 cell count at ART initiation was associated with better viral suppression (Muri *et al.*, 2016). Although CD4 count is becoming a less popular test in Kenya with the emergence of VL testing it reflects a recovering immune system as a result of better viral suppression. Most patients had initiated ART with a WHO stage I or II, however, WHO stage was not associated with viral suppression. This also contradicts a study conducted among adult patients in Vietnam where advanced clinical disease or WHO clinical stage 4 condition at the time of ART initiation was associated with virological failure (Huong *et al.*, 2011).

In this study, some patients had missing data on past infection with TB, but with the available data, history of TB infection was not significantly associated with viral suppression or non-suppression. Though this study collected data on past history of TB infection, having an active opportunistic infection like tuberculosis was associated with low viral suppression across all age categories in Uganda (Bulage *et al.*, 2017). In South Africa, patients on TB treatment had an unsuppressed viral load (Joseph Davey *et al.*, 2018). The difference in the findings could be explained by the fact that data was collected on past history of tuberculosis and not active TB or being on TB treatment. A study in South Africa showed that ongoing HIV replication and high viral load to be an important risk factor for TB (Fenner *et al.,* 2017), this could explain the high viral load in patients with active TB or on TB treatment in the two studies above.

5.5 Treatment factors associated with viral suppression amongst adolescents

Treatment factors associated with viral suppression were explored, most of the adolescents were initiated on non-nucleoside reverse transcriptase inhibitor (NNRTI based regimen nevirapine ((NVP) or efavirenz (EFV). However, this did not seem to affect viral suppression, this could be explained by the fact that a very small proportion of adolescents were on a protease inhibitor (PI) based regimen at ART initiation and this could have affected the findings. Nevirapine has for a long time been used routinely as a first line ART regimen in Kenya. This includes use of single dose nevirapine by the mother or extended nevirapine for infants for prevention of mother to child transmission (PMTCT). Unfortunately past use of NVP for PMTCT was not assessed in this r study. Non-nucleoside reverse transcriptase inhibitor drugs has low genetic barrier with increased risk of development of mutations and drug resistance. Other studies have associated NNRTIs or a nevirapine based ART regimen with increased risk of virological failure (Muri et al., 2016; Makadzange *et al*, 2015; Bunupuradah *et al*., 2015). Bain-Brickley *et al.* (2011) and Muri (2016) who demonstrated that adolescents on lopinavir/ritonavir (LPV/r) containing regimen had better viral suppression.

Current ART regimen was also evaluated; majority of the adolescents in the study were still on their 1st line ART regimen and had achieved viral suppression. Those on second line were less likely to be suppressed. Studies have demonstrated that adherence to first-line ART is an important predictor of adherence to second-line ART (Ramadhani *et al*., 2014). Barriers to adherence should be addressed in patients with suboptimal adherence before switching into second-line therapy to improve their outcomes. The Kenya ART guidelines recommend use of a boosted PI based regimen with two nucleoside reverse transcriptase inhibitors (NRTIs), after failure of a non-nucleoside reverse transcriptase inhibitor (NNRTI)-based first-line treatment. The possible choice of boosted PI is between ritonavir-boosted atazanavir (ATZ/r) and ritonavir-boosted lopinavir (LPV/r), (MOH, 2016). Adolescents often complain of the unpalatability and large size of the two boosted PI formulations this may lead to poor adherence and non-suppression for adolescents on 2nd line ART regimens.

The study did not evaluate timeliness in switching to effective ART regimens after failure. Timeliness in switching to effective ART regimens after failure may affect viral suppression. Children and adolescents with delayed switching from a failing ART regimen to an effective one, experience virological failure and are at an increased risk of accumulating drug resistance and mutations, resulting in fewer choices of active ARVs and a poor response to the new therapy (Salou *et al*., 2016).

5.6 Behavioral factors that are associated with viral suppression among adolescents

Two behavioral factors likely to affect viral suppression were assessed namely; adherence to ART and disclosure. Those with good adherence to ART were more likely to be virally suppressed, compared to those with inadequate or poor adherence. Good adherence to the ART is crucial for successful viral suppression, as incomplete adherence leads to an increase in HIV viremia, risk of treatment failure, and accumulating resistance mutations (Li, 2014). The finding were similar to other studies that have demonstrated that suboptimal adherence to ART is associated with virological failure in children and adolescents (Muri *et al.*, 2016). Similarly, Abreu *et al.* (2017) and Bulage *et al.* (2017) in different studies demonstrated that poor adherence to ART was associated with low viral suppression. Patients achieving 100% 12-month adherence were significantly more likely to exhibit virologic suppression (Nachega *et al,* 2009). In a one to one unmatched case control study conducted in Zimbabwe, poor adherence among others was an independent risk factor for virological failure (Sithole *et al,* 2018) Non-adherence to medications was associated with high viral load of ≥1000 copies/mL in an Ethiopian study (Hailu *et al.*, 2018), similarly in a study describing predictors of antiretroviral treatment adherence among a diverse cohort of adolescent's nonadherence by self-report was associated with higher viral load (Chandwani *et al.*, 2012).

In this study being aware of one's HIV status (disclosure) was not significantly associated with viral suppression. There was a very small proportion of adolescents recorded to be unaware of their own HIV status and this may have affected the findings. A study done in South Africa associated disclosure with adherence and viral suppression (Bernheimer *et al.* 2015) and delayed disclosure affected adherence and viral suppression in pre-adolescent and adolescent patients. A qualitative study conducted in Uganda had similar findings where delay in disclosing HIV status to perinatally infected children prior to adolescence were common and leading to non-adherence (Inzaule *et al,* 2016). In Zimbabwe, non-disclosure increased the odds of virological failure (Sithole *et al.*, 2018) and in Nigeria disclosure of HIV status predicted a better adherence to ART (Ugwu & Eneh, 2013). On the contrary fear of disclosing HIV status to others, especially boy/girlfriends, were important contributors to suboptimal adherence (Xu *et al.,* 2017).

A high proportion of adolescents (80%) were suppressed with good adherence to ART being the single most important factor associated with viral suppression. Age and gender were not associated with viral load suppression among the adolescents. However, those who initiated ART at ages 5-9 years and 10-14 years were less likely to be virally suppressed. The CD4 count and WHO stage at ART initiation were not significantly associated with viral suppression, but adolescents who had a current CD4 count above 500cells/mm3 were more likely to be suppressed. Majority of the adolescents were initiated on non-nucleoside reverse transcriptase inhibitor (NNRTI) based regimen). However, this did not seem to affect viral suppression. A large proportion of the adolescents were currently on first line ART regimen and had achieved viral suppression, unfortunately the small proportion of adolescents on second line ART regimen were less likely to be suppressed. Most adolescents were aware of their HIV status and awareness of one's HIV status (disclosure) was not significantly associated with viral suppression.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Viral suppression among adolescents in this study has improved significantly over time, but it is still below the target of 90%. Adherence was the single most important factor associated with achievement of viral suppression; good adherence in key regardless of current age, age at ART initiation, duration on ART, gender, and ART regimen the adolescent is on. Adherence is particularly critical for viral suppression in adolescents who were initiated on ART in pre adolescence and early adolescence stage. The study echoes the significance of ART on immune recovery and viral suppression, where adolescents with CD4 count above 500 cells/mm^3 had also achieved viral suppression.

6.2 Limitations

The major limitation of this study was use of programme data, records with missing variables were encountered. To mitigate this, pharmacy records, laboratory and the patient's clinic records were used to complete any missing data in the EMR. Values that were missed completely were dropped automatically from each variable and analysis conducted based on the totals with complete records. This may have affected the analysis of factors associated with viral suppression.

Second, a cross-sectional study design was used, which could not allow causality to be established, since exposures and the outcomes were measured at the same time.

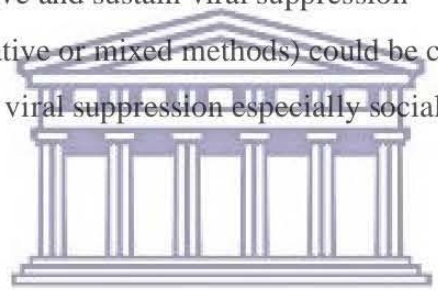
Finally, the study involved retrospective extraction of data from the EMR, restricting us to routinely collected variables; hence limiting the extent to which other variables such as social, cultural and economic factors affecting viral suppression could be measured.

The strength of this study was its fairly large sample size derived from 5 sub county hospitals and one major county referral hospital and thus provides a near true reflection of viral suppression among adolescents receiving ART in Homabay County.

6.3 Recommendations

The recommendations are targeted at improving and sustaining adherence to ART which was found to be the single most important factor associated with viral suppression. It also includes programmatic and policy recommendations to optimise adherence and viral suppression among adolescents.

- Adherence is imperative for viral suppression and should be assessed at every visit to identify and address possible barriers to adherence for adolescents on ART.
- There is need for further investments in enhancing adherence support for adolescents on ART such as trained adherence counsellors.
- Barriers to adherence should be identified and addressed for all adolescents before switching into second-line therapy.
- Adolescents on second line therapy should receive intensified adherence support in order for them to achieve and sustain viral suppression
- Further studies (qualitative or mixed methods) could be conducted to identify other factors associated with viral suppression especially social, cultural and economic factors.



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Appendices

Appendix 1: Data Collection Tool

MEDICAL RECORDS ABSTRACTION TOOL

Facility Code: _____

Data Abstraction Code: _____

DEMOGRAPHIC CHARACTERISTICS

Date of birth_____

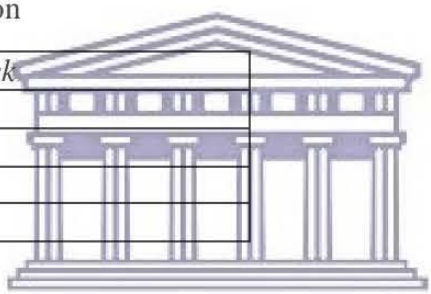
Age _____

Sex: Male _____ Female_____

CLINICAL INFORMATION

WHO Clinical stage at initiation

WHO Stage	*Tick*
Stage 1	
Stage II	
Stage III	
Stage IV	



CD4 counts at initiation_____

Last recorded viral load_____

Date of last recorded viral load _____

Recorded weight at the last visit_____

Recorded height at the last visit _____

BMI_____

Opportunistic infection acquired in the last 12 months

Did the patient ever have active TB in the last 12 months?

Yes _____

No_____

Other opportunistic infections in the last 12 months

_____

ART INFORMATION

Past exposure to ART through PMTCT

- Mother received Nevirapine_____
- Child received Nevirapine_____

Date of ART initiation_____

Age at ART initiation _____

ART regimen at initiation_____

Current Antiretroviral drug regimen the adolescent is on_____

Total duration on ART in Months_____

Dosage frequency of the current ART regimen

- Once a day
- Twice a day
- Other specify_____

Adherence to ART

Last recorded Morisky Medication Adherence Scale (MMAS-8)* **Attached*

_____

Disclosure of HIV status

- Adolescent aware of the HIV status
- Adolescent not aware of their HIV status.

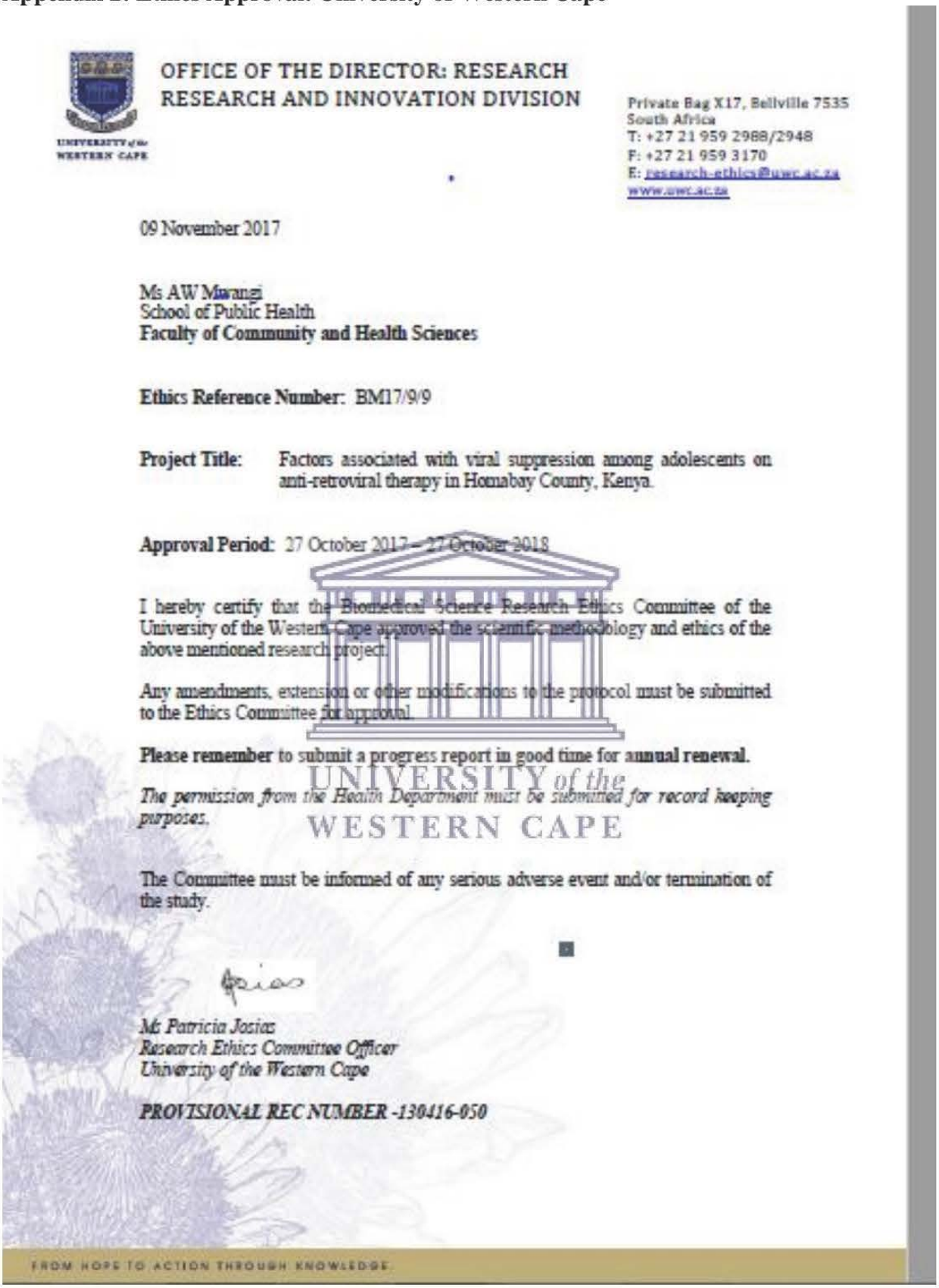
Table 1: Characteristics of the adolescent Patients

Variable	**Frequency (n)**	**Percent (%)**
Age group *10-14 years* *15-19 years*		
Sex *Male* *Female*		
Duration on treatment *0-2 years* *3-5 years* *6-10 years* *>10 years*		
Antiretroviral regimen at ART Initiation		

NNRTI based *PI based*		
Current ART treatment line *1st line* *2nd line* *3rd line*		
WHO Clinical stage *Stage 1* *Stage II* *Stage III* *Stage IV*		
CD4 counts at initiation *<200* *200-500* *>500*		
Did the patient ever have active TB *Yes* *No*		
Past exposure to ART through PMTCT *Mother received Nevirapine* *Child received Nevirapine*		
Age at ART initiation *0-4 years* *5-9 years* *10-14 years* *15-19 years*		
ART adherence *Poor <85%* *Fair 85-95%* *Good >95%*		
Disclosure		

Adolescent aware of HIV status *Adolescent unaware of HIV status*		

Appendix 2: Ethics Approval: University of Western Cape



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09 November 2017

Ms AW Mavangi
School of Public Health
Faculty of Community and Health Sciences

Ethics Reference Number: BM17/9/9

Project Title: Factors associated with viral suppression among adolescents on anti-retroviral therapy in Homabay County, Kenya.

Approval Period: 27 October 2017 – 27 October 2018

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for **annual renewal.**

The permission from the Health Department must be submitted for record keeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER -130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE

Appendix 3: Ethics Approval: AMREF Health Africa

amref health africa

Amref Health Africa in Kenya

REF: AMREF – ESRC P418/2017

January 22, 2018

Anne Mwangi,
Elizabeth Glaser Pediatric AIDS Foundation,
P.O. Box 523-00202 Nairobi.
Tel: 0722407174
Email: mwannie2003@gmail.com

Dear Dr. Mwangi,

RESEARCH PROTOCOL: FACTORS ASSOCIATED WITH VIRAL SUPPRESSION AMONG ADOLESCENTS ON ANTIRETROVIRAL THERAPY IN HOMA BAY COUNTY, KENYA

Thank you for submitting your protocol to the Amref Health Africa Ethics and Scientific Review Committee (ESRC).

This is to inform you that the ESRC has approved your protocol. The approval period is from January 22, 2018 to January 23, 2019 and is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc.) will be used.
b) All changes (amendments, deviations, violations etc.) are submitted for review and approval by Amref ESRC before implementation.
c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the ESRC immediately.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to Amref ESRC immediately.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period (attach a comprehensive progress report to support the renewal).
f) Clearance for export of biological specimen or any form of data must be obtained from Amref ESRC, NACOSTI and Ministry of Health for each batch of shipment/export.
g) Submission of an executive summary report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

Please do not hesitate to contact the ESRC Secretariat (esrc.kenya@amref.org) for any clarification or query.

AMREF - ESRC 25 JAN 2018 P.O. Box 30125 - 00100, NAIROBI

Yours sincerely,

Prof. Mohamed Karama
Chair, Amref Health Africa ESRC

CC: Dr. George Kimathi, Director Institute of Capacity Development, Amref Health Africa and Vice Chair Amref Health Africa ESRC
Samuel Muhula, Monitoring & Evaluation and Research Manager, Amref Health Africa in Kenya

Winner of the Gates Award
BILL & MELINDA GATES FOUNDATION

Appendix 4: Approval Letter: Ministry of Health, Homabay County

MINISTRY OF HEALTH

Telegrams: "MOH" Homa Bay
Telephone: 21039
When replying please quote

MINISTRY OF HEALTH,
HOMA BAY COUNTY,
P.O. BOX 52,
HOMABAY.

REF:MOH/RA/VOL.1 (62)

04 April 2018

Anne Mwangi
Elizabeth Glazer Pediatric Foundation
P O Box 523-0002020
NAIROBI

RE: AUTHORITY TO CONDUCT RESEARCH

Following your request to extract data from EMR in Homa Bay County on your research proposal entitled **"Factors Associated with Viral Suppression among Adolescents on Antiretroviral Therapy in Homa Bay County"** *has* been approved for the period ending June 2018.

You will be required to adhere to the hospital's norms and regulations, and involve both the County Health Management Team and hospital's staff during the research period. You are also expected to communicate your findings to the hospital's management plus the Directors' office at the end of the research period.

Wish you all the best in your research.

Dr. Okomo Gordon
County Director of Health
HOMABAY