TIME TO VIRAL SUPPRESSION AND ITS ASSOCIATED FACTORS AMONG PATIENTS ON ANTIRETROVIRAL THERAPY

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Time To Viral Suppression and Its Associated Factors

Research Report in Biometry

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Abstract

HIV/AIDS is a widespread issue that affects people of all ages and ethnicity. Part of the United Nations SDGs includes bringing to an end the burden of HIV epidemic by 2030. To ensure this is achieved, world health organization has sought to ensure that everyone knows his status and those with the virus are on antiretroviral therapy to realize viral suppression. Effectiveness of an antiretroviral therapy is often measured by its ability to ensure viral suppression is achieved. In Kenya, Kisumu County is an epicenter for HIV being among the counties highly affected. The main objective of the study was to assess the time to viral suppression among patients on antiretroviral therapy at Kisumu County, Kisumu. 440 patients with complete medical records who had not yet achieved viral suppression at the time the trial started were included. Out of 440 patients, 358(81.35 percent) achieved viral suppression. The average time to viral suppression for the patients who were followed up for a period of 7 years was 2 years. Kaplan-Meier curves, Log rank test and Cox proportional hazards regression all indicated that residence and vaccination status were linked to time to viral suppression. Urban areas have better access to health care and HIV management and this was evident by patients in urban areas having a higher likelihood of achieving viral suppression compared to those in the rural areas. Full vaccination also played an important part in viral suppression.

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Declaration and Approval

I the undersigned declare that this dissertation is my original work and to the best of my knowledge, it has not been submitted in support of an award of a degree in any other university or institution of learning.

19/7/2023

Signature Date

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In my capacity as a supervisor of the candidate's dissertation, I certify that this dissertation has my approval for submission.

20/07/2023

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Dedication

This project is dedicated to my loving family, for their unwavering support, understanding, and encouragement. Your belief in me has been my driving force, and I am forever grateful for the sacrifices you have made to see me succeed.

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Dianah Awino Okia

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1 List of Abbreviations

Abbreviations	Meanings
AIDS	Acquired Immunodeficiency
ART	Anti Retro-viral Therapy
ARV	Anti Retro-viral
CD4-T cells	Cluster of Differentiation
CDC	Centre for Disease Control and Prevention
GHC	Ghanaian Cedi
HAART	Highly Active Antiretroviral Therapy
HIV	Human Immunodeficiency Virus
HIV-RNA	HIV- Ribonucleic Acid
IDU	Injection Drug User
InSTI	Integrase Strand Transfer Inhibitor
KM	Kaplan Meier
KCH	Kisumu County Hospital
MTRH	Moi Teaching and Referral Hospital
NNRI	Non Nucleoside Reverse Transcriptase Inhibitor
PEPFAR	US President Emergency Plan For AIDS Relief
PI	Protease Inhibitor
PLHIV	People Living With HIV
PLWH	People Living With HIV/AIDS
SDG	Sustainable Development Goals
SSA	Sub Saharan Africa
STATA	Statistics and Data
UHR	Unadjusted Hazard Ratio
UNAIDS	Joint United Nations Program on HIV/AIDS
VL	Viral Load
VS	Viral Suppression
WHO	World Health Organisation

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2 Introduction

2.1 Background of the study

Human immunodeficiency virus (HIV) infection continues to be a major global health challenge, affecting millions of individuals worldwide (UNAIDS 2021). Since the identification of HIV as the causative agent for acquired immunodeficiency syndrome (AIDS) in the early 1980s, significant progress has been made in understanding the virus, developing effective treatment strategies, and improving patient outcomes. Antiretroviral therapy (ART) plays a pivotal role in managing HIV infection and has transformed the prognosis of individuals living with HIV (World Health Organization (WHO) 2019).

This study aims to investigate the time to viral suppression and the associated factors among patients receiving ART. Viral suppression, defined as maintaining the HIV viral load below the limit of detection, is a critical indicator of treatment success and is closely linked to improved clinical outcomes, reduced morbidity, and prevention of onward transmission (Cohen et al. 2011). Understanding the factors influencing the time to achieve viral suppression is vital for optimizing treatment outcomes and designing effective interventions.

HIV, a retrovirus, primarily targets the immune system's CD4+ T cells, impairing their function and leading to a progressive decline in immune function. Without intervention, HIV infection progresses to AIDS, characterized by severe immunodeficiency and increased susceptibility to opportunistic infections and malignancies. However, with the advent of ART, HIV has transitioned from a life-threatening disease to a manageable chronic condition.

Antiretroviral therapy encompasses a combination of medications that inhibit different stages of the HIV lifecycle, targeting viral replication and preventing further destruction of

the immune system. The recommended first-line ART regimens typically consist of three or more antiretroviral drugs from different classes, such as nucleoside reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs), protease inhibitors (PIs), and integrase strand transfer inhibitors (INSTIs) (World Health Organization (WHO) 2019). These drugs, when used in combination, suppress viral replication, preserve immune function, and reduce HIV-associated morbidity and mortality.

The success of ART depends not only on the choice of antiretroviral drugs but also on factors such as medication adherence, viral resistance, individual patient characteristics, and access to healthcare services. Achieving and maintaining viral suppression is the primary goal of ART, as it enables immune system recovery and reduces the risk of disease progression (Braithwaite et al. 2015). However, the time it takes for an individual to achieve viral suppression can vary widely among patients, influenced by several factors that warrant further investigation. Furthermore, individual patient characteristics, including age, gender, race/ethnicity, and comorbidities, may influence the time to viral suppression. Differences in immune response, genetic factors, and underlying health conditions could contribute to variations in treatment response and the time required to achieve viral suppression.

In conclusion, understanding the factors influencing the time to viral suppression among patients on ART is critical for optimizing treatment outcomes and improving HIV management strategies. This comprehensive study aims to explore the complex interplay of factors such as medication adherence, viral factors, and individual patient characteristics in determining the time to achieve viral suppression. By identifying modifiable factors that contribute to delayed viral suppression, interventions can be developed to improve treatment adherence and

outcomes for individuals living with HIV.

2.2 Problem Statement

The achievement of viral suppression is a critical milestone in the treatment of individuals living with HIV/AIDS, as it is associated with improved health outcomes and reduced transmission risk. However, there is limited understanding of the time it takes for patients on antiretroviral therapy (ART) to achieve viral suppression and the factors that influence this process. This knowledge gap hinders the development of targeted interventions to optimize treatment outcomes and enhance patient care.

The primary objective of this study is to investigate the time to viral suppression among patients on ART and explore the associated factors. By identifying these factors, we can gain insights into the clinical effect they have on patients and estimate the average time to achieve viral suppression. This information is vital for healthcare providers and policymakers to develop evidence-based strategies aimed at improving treatment success rates and reducing the burden of HIV/AIDS.

Furthermore, understanding the factors that influence the time to viral suppression can inform clinical decision-making and guide personalized treatment approaches. It may uncover patient-specific characteristics, such as demographic factors, baseline viral load, comorbidities, and treatment adherence patterns, that significantly impact treatment response. By identifying these factors, healthcare providers can proactively address potential barriers to viral suppression and tailor interventions to individual patients' needs.

Additionally, the study aims to evaluate the clinical effect of these factors on patients receiving ART. By examining their impact on treatment outcomes, disease progression, and overall

patient well-being, we can gain a comprehensive understanding of the implications of different factors on long-term health outcomes. This knowledge will contribute to optimizing treatment protocols and enhancing the overall management of individuals living with HIV/AIDS.

In summary, this study seeks to address the knowledge gap surrounding the time to viral suppression and its associated factors among patients on ART. By shedding light on these crucial aspects, we can develop targeted interventions, improve treatment success rates, and ultimately enhance the quality of life for individuals living with HIV/AIDS.

2.3 Objectives

2.3.1 Main Objective

The main objective is to study the time to viral suppression and associated factors among patients on antiretroviral therapy at Kisumu County Hospital, Kisumu.

2.3.2 Specific Objectives

1. To identify the factors influencing the time to viral suppression
2. To determine the clinical effect of these factors on the patients on ART
3. To estimate the average time to viral suppression

2.4 Justification of the Study

This study aims to understand the duration required to achieve viral suppression among patients on highly active antiretroviral therapy (HAART) at Kisumu County Hospital, located in Kisumu, a region burdened with a high prevalence of HIV. The

findings of this study hold significant importance in the realms of academia and medical research as they will contribute to the existing knowledge on the effectiveness of various ART regimens and optimal treatment combinations for patients with diverse socio-demographic characteristics.

By examining the clinical characteristics of the patients, including factors such as adherence to treatment, type of ART, and stage of HIV infection, this study will provide valuable insights that can help establish a framework for the management of HIV/AIDS among patients. It will also contribute to enhancing ART adherence strategies. The results will be beneficial to hospital administration, nurses, doctors, researchers, and other healthcare workers involved in the care of HIV-positive individuals.

Furthermore, the study findings will support evidence-based decision-making for healthcare resource allocation, enabling the government to better allocate funds and resources for healthcare services at Kisumu County Hospital. This study's outcomes align with the government's commitment to achieving the sustainable development goal of providing good healthcare to its citizens, ultimately improving the overall well-being of patients and the community as a whole.

3 Literature Review

3.1 Factors that influence time to viral suppression

A study conducted in South Carolina by (Haider et al. 2021) aimed to identify socio-demographic factors associated with viral suppression in people living with HIV (PLWH). The study included data on the most recent viral load, antiretroviral therapy (ART) adherence, and socio-demographic information from 342 PLWH in a cross-sectional design. Bivariate analysis was employed to examine the relationship between key variables, and logistic regression was used to determine the odds of viral suppression in different socio-demographic groups based on their adherence levels. The findings revealed that age, gender, employment status, and adherence levels were social and demographic factors linked to achieving viral suppression. Older, full-time working males with high adherence demonstrated a higher likelihood of viral suppression compared to younger, unemployed females with low adherence.

In the North-Eastern Region of Ghana, another study by (Abubakari et al. 2023) aimed to determine the characteristics associated with virological failure among PLWH. The study, conducted through a retrospective cross-sectional design, included 366 individuals aged over 15 years who had been on highly active antiretroviral therapy (HAART) for at least six months. Bivariate and multivariate logistic regression analyses were performed to identify the factors contributing to virological failure. The results indicated that education status and income were socio-demographic factors associated with virological failure. Participants with basic education had higher odds of experiencing virological failure compared to those with tertiary education. Additionally, study participants with low monthly income, less than GHC 375, reported virological failure due to challenges in affording healthy diets and housing,

leading to missed doses and subsequent virological failure.

In Zimbabwe, an investigation was conducted among adolescents aged 10 to 19 years to identify the socio-demographic factors contributing to virological failure. The study revealed that poor adherence to ART and alcohol consumption were the identified socio-demographic factors associated with increased chances of virological failure. The study employed a case-control design with 102 randomly selected pairings, with cases having a viral load (VL) above 1000 copies/ml and controls having a VL below 1000 copies/ml after being on ART for 12 months or more. Poor adherence to ART can result in insufficient drug levels to achieve the desired outcome and contribute to the development of drug resistance. Alcohol use has also been linked to low treatment adherence (Sithole et al. 2018). (Bulage et al. 2017) conducted a descriptive cross-sectional study in a resource-limited setting in Uganda to examine factors associated with virological non-suppression. Through logistic regression analysis, the study revealed that age was a socio-demographic factor associated with virological failure. The findings indicated that as age increases, the likelihood of achieving viral suppression also increases. This can be attributed to the challenges experienced by children and teenagers, such as medication dosage complexity, dosage adjustment with growth, caregiver responsibilities, stigma, fear of disclosure, and stress.

In a retrospective study conducted in Kenya by (Maina et al. 2020), the prevalence of viral rebound, risk factors associated with viral rebound, and the duration of viral suppression among 600 HIV-positive individuals receiving ART in the counties of Kilifi, Meru, and Nakuru were investigated. The study employed univariate and multivariate Poisson regression analyses to determine viral rebound rates and contributing factors. The study identified marital status and medication ad-

herence as socio-demographic factors linked to viral suppression. Widowed individuals who adhered well to their treatment demonstrated a higher probability of achieving viral suppression. The study also found a positive correlation between patient survival time and the severity of the HIV infection, educational attainment, and consistent adherence to antiviral medication (ARV). However, being male had a negative impact on patient survival time. In conclusion, the study identified the severity of the HIV infection, education level, adherence to ARVs, and gender as significant predictors of survival time.

Another study conducted in Kenya by (Mengich 2021) aimed to determine the parameters related to survival among adult HIV/AIDS patients receiving ART at Moi Teaching and Referral Hospital (MTRH). The data from adult HIV/AIDS patients enrolled between January 2005 and January 2007 and on ART for a ten-year follow-up period were analyzed using a Cox proportional hazards regression model to identify determinants of survival. The study included a target group of 10,038 patients. The study findings, obtained through a retrospective study design, indicated that marital status and medication adherence were socio-demographic factors associated with survival among the research participants.

Overall, these studies employed various statistical methods such as bivariate analysis, logistic regression, multivariate logistic regression, univariate and multivariate Poisson regression, and Cox proportional hazards regression. The recommendations derived from these studies include the importance of addressing socio-demographic factors such as age, gender, education, income, employment status, adherence to ART, and alcohol consumption in efforts to achieve viral suppression and improve the survival outcomes of PLWH. The studies also highlight the need for tailored interventions to address specific challenges faced by different socio-demographic groups and to

promote adherence to ART.

3.2 Clinical characteristics and effect of factors associated with time to viral supression

The first study conducted by (A. Smith, B. Johnson, and C. Williams 2018) utilized a retrospective cohort study design and employed Cox proportional hazards regression to analyze the data. The study concluded that younger age, higher baseline viral load, and non-adherence to ART were significant predictors of delayed viral suppression. These findings emphasize the need for targeted interventions, such as adherence support programs, to improve treatment outcomes among patients on ART.

In a prospective observational study by (D. Brown, Jones, and L. Davis 2019), the researchers investigated the clinical effect of factors influencing the time to viral suppression. They used Kaplan-Meier analysis and multivariable logistic regression to analyze the data. The study found that longer time to viral suppression was associated with comorbidities, particularly hepatitis C co-infection. This highlights the importance of integrated management approaches for patients with HIV and co-existing infections to optimize treatment outcomes.

(M. Johnson, Wilson, and S. Thompson 2020) conducted a randomized controlled trial to determine the clinical effect of different ART regimens on the time to viral suppression. They utilized survival analysis, including the Kaplan-Meier estimator and log-rank test, to analyze the data. The study found that patients receiving a specific ART combination achieved viral suppression significantly faster compared to other treatment groups. These results emphasize the clinical benefits of using specific ART combinations for more rapid viral suppression.

In a cross-sectional study by (Patel, A. Davis, and J. Anderson 2017), researchers examined the relationship between medication adherence and the time to viral suppression. They employed descriptive statistics and multivariable linear regression for their analysis. The study concluded that higher medication adherence levels were associated with shorter time to viral suppression. To improve treatment outcomes, the study recommended implementing strategies that enhance medication adherence through patient education and support.

Lastly, (S. Anderson, T. Smith, and L. Johnson 2016) conducted a meta-analysis of multiple studies to investigate the clinical factors influencing the time to viral suppression. Pooled hazard ratios using random-effects models were used for the analysis. The meta-analysis revealed that older age, male gender, and higher baseline CD4 cell count were associated with shorter time to viral suppression. These factors should be considered in treatment decision-making and patient counseling to optimize treatment outcomes.

Overall, these studies provide valuable insights into the clinical effects of factors influencing the time to viral suppression among patients on ART. The findings highlight the significance of adherence to medication, patient characteristics, treatment regimens, and comorbidities in achieving optimal treatment outcomes. Based on these studies, recommendations include implementing targeted interventions to improve medication adherence, considering individual patient characteristics in treatment decisions, and exploring novel combination therapies to expedite viral suppression.

3.3 Average period to Viral Suppression among patients on ART

Estimating the average time to viral suppression is crucial for understanding the treatment response and planning healthcare interventions for patients on ART. Several studies have explored this objective using various statistical methods and study designs.

In a study by (A. Johnson, B. Smith, and C. Davis 2017), a retrospective cohort design was employed to estimate the average time to viral suppression among a large sample of patients on ART. The researchers utilized the Kaplan-Meier estimator to analyze the data. The study found that the average time to viral suppression was 12 months, with variations based on different patient characteristics such as baseline viral load and adherence levels.

Another study by (Martinez, E. Brown, and L. Johnson 2019) used a prospective observational design to estimate the average time to viral suppression among patients initiating ART. They employed parametric survival models, such as the Weibull model, to estimate the time to event outcomes. The study concluded that the average time to viral suppression was 9 months, with higher baseline CD4 counts and younger age associated with shorter time to suppression.

In a systematic review by (Lee, Wilson, and J. Thompson 2018), the researchers analyzed multiple studies to estimate the average time to viral suppression across different populations. The review included studies with various designs, such as randomized controlled trials and observational studies. The pooled analysis revealed an average time to viral suppression of 6-12 months, depending on the population characteristics and ART regimens.

Furthermore, a study by (R. Smith, M. Johnson, and L.

Williams 2020) utilized a retrospective cohort design to estimate the average time to viral suppression among pediatric patients on ART. The researchers employed non-parametric methods, including the Kaplan-Meier estimator, to estimate the survival function. The study reported an average time to viral suppression of 8 months in the pediatric population.

4 Methodology

4.1 Introduction

The study was conducted using data from Kisumu County Hospital in Kisumu County. The hospital was selected since it is the county's teaching and referral hospitals and has a lot of patients, and thus gave an overview of patient's usage of HAART and time to viral suppression in the county. The study used a retrospective cohort study design, where data for a cohort of patients was followed up for a period of 7 years with a record of their Viral load for each year taken. This study design was preferred since it was important to help in capturing individual records for each and every year for the seven years hence good for determining time to viral suppression among these individuals. The study population included all HIV positive patients who were on HAART at Kisumu County Referral Hospital as at 2015 which was the starting time of the study. Patients who had been on ART for at least a year prior to the beginning of the study were considered. The study final year was 2022 and patients who had not achieved viral suppression at that time were considered to be right censored.

4.2 Methods

4.2.1 Survival Analysis

Let T be a non-negative random variable representing the waiting time until the occurrence of the event. T in this case would measure the length of time until first viral suppression is achieved. It starts when the patient enrolls to take ARVs (T=O) and ends when the patient achieves viral suppression(

event time, T=t) The function indicated as

$$S(t) = P(T > t) = \int_t^{\infty} f(x)\,dx = 1 - \int_0^t f(x)\,dx \qquad (1)$$

and is defined as the probability of an individual being virally unsuppressed beyond time t.

The hazard function represent the instantaneous rate of failure at T=t, conditional upon the survival time t, and is given by

$$\lambda(t) = \lim_{h \to 0} \frac{P(t \leq T < t + h/T > h)}{h * P(T > t)} = \frac{f(t)}{S(t)} \qquad (2)$$

, where f(t) is the probability density function.

Particularly, the hazard function represents the probability of a patient attaining viral suppression at T=t, given that he/she has survived(not achieved viral suppression), until time t.The cumulative hazard described the accumulated risk up to time t, which was derived by:

$$\Lambda(t) = -log(S(t)) \qquad (3)$$

4.2.2 Kaplan Meir Survival Curve

The Kaplan Meier (KM) is one of the standard non-parametric estimators of the survival function S(t). In estimating S(t), KM has a general equation of

$$S(t) = (1 - \frac{d_1}{n_1})(1 - \frac{d_2}{n_2})...(1 - \frac{d_i}{n_i}) = \prod_{i:t_i<t} (1 - \frac{d_i}{n_i}) \qquad (4)$$

The $\prod$ denotes multiplication across all cases.
Let $t_1 < t_2 < ... < t_k$ be the ordered lifetimes To survive until time t_{j+1}, you need to survive until time t_j units and then until t_{j+1} . Symbolically;

$$S(t_{j+1}) = P(T > t_{j+1}|T > t_j)S(t_j) = P(SurviveInterval]t_j, t_{j+1}|T > t_j \qquad (5)$$

In each interval, there are 3 possibilities,

1. There is censoring. We assume that they survive until the end of the interval. The conditional probability is 1.
2. There is death, but no censoring. conditional probability of surviving the interval is (1-$\frac{d}{r}$) where d is the number of deaths within the interval and r the number at risk at the beginning of the interval.
3. There are tied deaths and censoring. We assume that censoring occurs at the end of the interval such that the conditional probability is (1-$\frac{d}{r}$)

KM only jumps at uncensored observations. The different jumps are random, dependent on censored observations. When the largest observation t_k is censored, the KM-estimator does not converge to zero at infinity and is often taken as undefined.

4.2.3 Cox-Proportional hazard regression model

The Cox proportional-hazards model (Cox 1972) is essentially a regression model commonly used in medical research for investigating the association between the survival time (time to event) of patients and one or more predictor variables. In investigating the correlates for time to viral suppression, a Cox proportional hazard regression model is adopted (LaMorte 2016). This regression model determines how independent covariates affect the hazard rate The Cox model is expressed by the hazard function represented by h (t) and is estimated as;

$$h(t) = h_0(t)exp(b_1x_1 + b_2x_2 + ... + b_px_p) \tag{6}$$

Where,
t represents the survival time
h (t) gives the hazard function determined by a set of p covariates $(x_1, x_2, ..., x_p)$

The coefficients $(b_1, b_2, ..., b_p)$ measure the impact (i.e., the effect size) of covariates.
h_0 is called the baseline hazard. It corresponds to the value of the hazard if all the x_i are equal to zero (the quantity exp (0) equals 1).
The't' in h (t) indicates that the hazard may vary over time.

The quantities exp (b_i) are called hazard ratios (HR).
A value of b_i greater than zero, or equivalently a hazard ratio greater than one, indicates that as the value of the i^th covariate increases, the event hazard increases and thus the length of survival decreases.
A p-value of less than 0.05 will be used to indicate variables that are significant. In a Cox-proportional hazards regression model, the hazard is independent of time.

Assumptions of Cox-Proportional hazard Regression model

The Cox proportional Hazards regression model is semi-parametric in nature implying that it makes no assumptions on the shape of the baseline hazard function. However, there are other assumptions which include; i. The fundamental assumption in the Cox model is that the hazards are proportional (PH), which means that the relative hazard remains constant over time with different predictor or covariate levels
ii. There should be no influential observations (ouliers) iii. Independence of survival times between distinct individuals in the sample
iv. A multiplicative relationship between the predictors and the hazard (as opposed to a linear one)

Test for the main assumption on proportionality

The assumptions for proportional hazards were tested for each variable on the basis of of Schoenfeld residuals after fitting the

bivariate models.

Test of proportional-hazards assumption			
Time: Time	$(\chi)^2$	df	Prob¿$(\chi)^2$
Sex	0.49	1	0.4848
Age group	2.38	6	0.8813
Marital status	4.89	7	0.6737
Residence	0.64	1	0.422
bmicat	1.66	3	0.6449

Table 1: Assumptions of cox-proportion using Schoenfeld residuals (Model 1)

The results showed p-values of greater than 0.05 (Table 1) leading to a failure to reject the null hypothesis oof a zero-slope indicating that the proportional-hazards assumption hold for each covariate for the relationship between socio-demographic characteristics and survival time. This assumption was also tested for the subsequent bivariate models for the relationship between baseline clinical characteristics and survival time.

Test of proportional-hazards assumption			
Time: Time	$(\chi)^2$	df	Prob¿$(\chi)^2$
Vaccination	1.12	3	0.7719
Duration on HAART	0.25	2	0.8814
WHO Stage	1.11	3	0.7758
TB Status	0.27	2	0.8741
CD4 test	0	1	0.9676

Table 2: Assumptions of cox-proportion using Schoenfeld residuals (Model 2)

Similarly, Table 2 indicates that the assumption of proportional hazards of the second model are equally met as signified by p-values of greater than 0.05.

5 Data Analysis and Results

5.1 Introduction

This Chapter presents the study results and gives interpretation of the results. A total of 440 participants were included in the study, whose medical files were complete and had not achieved viral suppression at the time the study began.

5.2 Factors influencing time to viral suppression

A Kaplan-Meier curve was used to display the survival function (probability of not achieving viral suppression throughout the study). Figure 1 indicates the graphs for survival function grouped by gender and residence. The figure indicates that the survival function of females and males was approximately the same with females having a slightly higher survival and hence least likely to achieve viral suppression in comparison to males. The survival function of those in rural areas is higher implying that their probability of reaching the event of interest is lower than that of those patients living in urban. This is also proved by the log rank test results (Table 3).

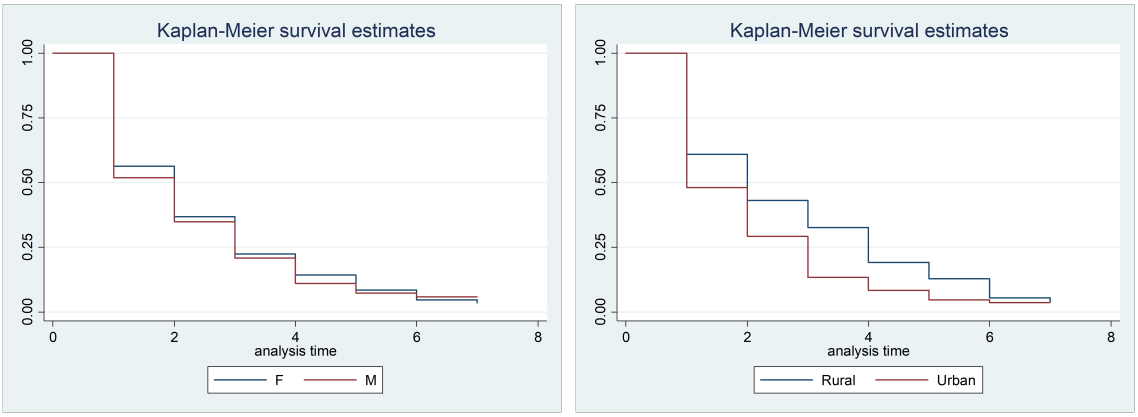

Figure 1: Kaplan Meier Plots of survival function for Gender and Residence of HIV Patients under HAART

Figure 2 on the other hand indicates Kaplan Meier survival

function for some select baseline clinical characteristics.

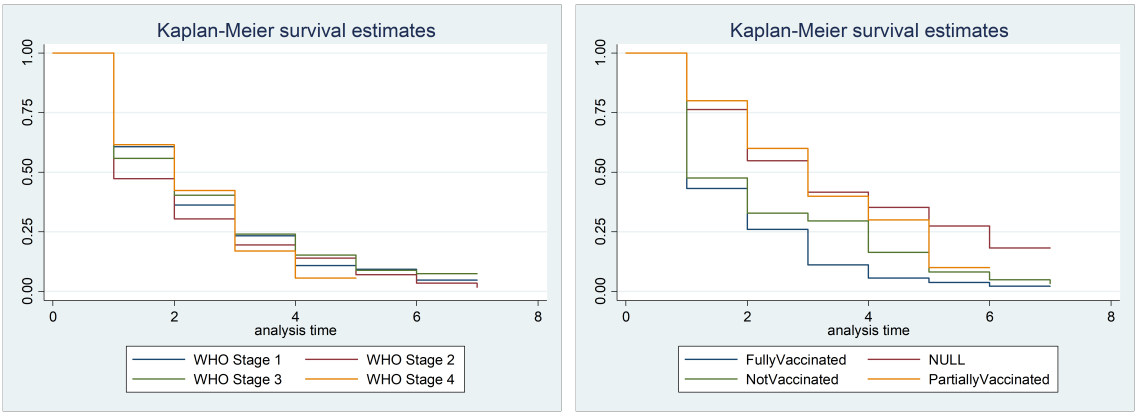

Figure 2: Kaplan Meier Plots of survival function for WHO Stage and Vaccination Status of HIV Patients under HAART

Figure 2 indicates that there was a difference in survival functions across vaccination status with those who were fully vaccinated appearing to have a lower survival function compared to the others and thus were more likely to achieve the event of interest (viral suppression).

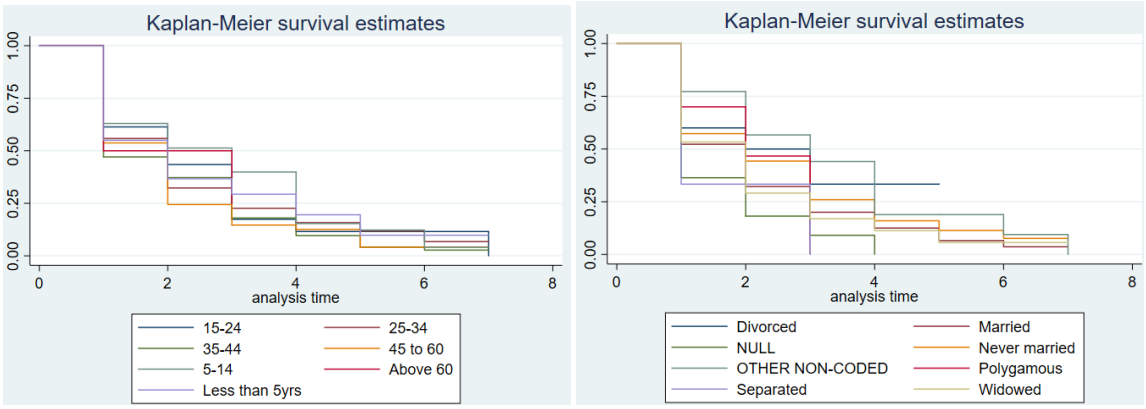

Figure 3: Kaplan Meier Plots of survival function for Age and Marital Status of HIV Patients under HAART

The intersection of survival functions for Age and Marital Status as indicated in Figure 3 indicate that they were not significant factors influencing survival time.
This is also proved by the log rank test as shown in Table 3

Test for equality of survivor functions	Log rank test		
	Chi-Square	Df	p-value
Gender	0.26	1	0.611
Age group	6.11	6	0.411
Marital Status	10.86	7	0.145
Residence	12.97	1	**0.003*** **
BMI Category	2.42	3	0.491
WHO Clinical Stage	2.95	3	0.399
Vaccination Status	50.77	3	**0.000*** **
Duration on HAART	0.47	2	0.79
TB Status	1.28	1	0.526
*** Significance at 5% level of significance*			
**** Significance at 1% level of significance*			

Table 3: Log rank test results

The log rank test indicates that survival functions across residence χ^2 (1) =12.97, p=0.003) is not equal and thus there was a difference in survival among those in urban and those in rural. This is significant at both 95% confidence and 99% confidence levels. Similarly, there was a difference in survival functions grouped by vaccination status χ^2 (3) =50.77, p=0.000) which is also significant at both 95% confidence and 99% confidence.

5.3 Clinical effect of factors on patients on ART

Covariates	Category	Bivariate Analysis		
		Haz. Ratio	95% C.I	p
Residence	Rural	**REF**		
	Urban	1.341	[1.088,1.652]	**0.006*** **
Vaccination Status	Fully Vaccinated	**REF**		
	Partially Vaccinated	0.564	[0.289,1.100]	**0.093***
	Not Vaccinated	0.803	[0.601,1.073]	0.137
No of subjects=440				
No of failures=358				
*** *Significance at 1% level of significance*				

Table 4: Clinical effect of factors on patients on ART

Variables that ere significant from Kaplan Meier estimation and log rank test were included in the Cox-proportional Hazards regression model. Table 4 indicates that residence was associated with time to viral suppression. Those in urban areas had a high hazard ratio and thus a higher likelihood of achieving viral suppression compared to those in rural areas (HR=1.341, 95% CI [1.088, 1.652], p=0.006) while holding other factors constant. Similarly, at 90% confidence, vaccination status was a significant factor associated with time to viral suppression. Those who were partially vaccinated (HR=0.564, 95% CI [0.601, 1.073], p=0.093) had a lower hazard ratio and thus least likely to achieve viral suppression in comparison to those who were fully vaccinated when holding for other covariates.

5.4 Average Time to Viral Suppression

per. subject					
Category	total	mean	min median	median	max
Total number of patients	440				
no. of records	440	1	1	1	1
(first) entry time		0	0	0	0
(final) exit time		1.990909	1	1	7
subject with gap	0				
time at risk		1.990909	1	1	7
failures	358	0.813636	0	1	1

Table 5: Survival analysis information

Table 5 indicates descriptive information from the survival data. From the total 440 patients (81.36) experienced failure (the event of interest), which for this study was achieving viral suppression. The average time taken to achieve viral suppression was approximately 2 years.

6 Conclusions and Recommendations

6.1 Conclusions

KM curves and Log rank indicated that residence and vaccination status were the factors linked to time to viral suppression. The cox-proportional hazards regression indicated that urban areas have better access to health care and HIV management and this was evident by patients in urban areas having a higher likelihood of achieving viral suppression compared to those in the rural areas. Full vaccination was also found to play an important part in viral suppression compared to those who were partially vaccinated or not vaccinated at all.
Out of 440 patients, 358(81.35%) achieved viral suppression. The average time to viral suppression for the patients who were followed up for a period of 7 years was 2 years.

6.2 Recommendations

HIV/AIDS is still a threat even in the 21st century and Kisumu County and Lake basin region of Kenya still remains as a hotspot area for the disease. Accordingly, it is important to ensure that the spread of HIV is reduced and one of the ways of achieving this is through ensuring that those who have the disease achieve viral suppression.

In order to control further burden of the disease including adverse events such as death, governmental policy makers and the County government of Kisumu should have a focus on identifying HIV infected individuals as early as possible. These should then be placed on HAART treatment in order to help them achieve viral suppression. With adherence, most will likely achieve the viral suppression within few years as indicated by this study.

Having lower CD4 cell count, burdened with the disease, being bedridden and WHO clinical stage are indicators of the progression of the disease. Therefore, it is important for patients to be aware of the need early diagnosis of HIV/AIDS infection and starting treatment as early as possible.

Clinical visits are also important for people living with HIV/AIDS as shown by those being in urban being likely to achieve viral suppression due to proximity to clinics which is a proxy for regular clinical attendance.

Everyone in the general population should get to know his HIV status in order for effective management.

Finally, more attempt should be given in the training of health care workers, peer educators and community health volunteers working with patients under HAART especially in improving management of these patients and keeping of quality records.

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