PREDICTORS OF TREATMENT FAILURE AMONG HIV POSITIVE CLIENTS IN WEBUYE SUB-COUNTY, BUNGOMA COUNTY, KENYA

NANCY EGEIZARH MULATI

MASTER OF SCIENCE

(Public Health)

JOMO KENYATTA UNIVERSITY

OF

AGRICULTURE AND TECHNOLOGY

2024

Predictors of Treatment Failure among HIV Positive Clients in Webuye Sub-County, Bungoma County, Kenya

Nancy Egeizarh Mulati

A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Public Health of the Jomo Kenyatta University of Agriculture and Technology

2024

DECLARATION

This thesis my original work and has not been presented for a degree in any other University

Signature……..Date……

Nancy Egeizarh Mulati

This thesis has been submitted for examination with our approval as the University Supervisors

Signature……..Date……

Prof. Simon Karanja, PhD

JKUAT, Kenya

Signature……Date……

Prof. Kenneth Ngure

JKUAT, Kenya

DEDICATION

To my Dad, Mum, Sisters (Mercy and Sharon) my children (Taraji and Jabali) and not forgetting my Hubby for the encouragement and support they accorded me throughout this study.

ACKNOWLEDGEMENT

I extend my sincere gratitude to my supervisors; Prof Simon Karanja and Dr. Kenneth Ngure. Thanks also to the Director Jomo Kenyatta university of Agriculture and technology- Eldoret campus, Dr. Chelule and Madam Betsy for their invaluable assistance throughout the investigation, as well as their capable direction and insightful advice when the study protocol was being developed. I am grateful to the Medical director of Webuye sub county hospital, Team lead Comprehensive Care centre for allowing me to undertake the study in their facility.

I also appreciate my friends Aura and Mideva for the support accorded to me during the entire study period.

Thanks for the psychosocial support from my classmates Ciddy, Margret, Erastus, Eliud, Leah, Clara, Lydia and Baraza.

I want to appreciate Jaramogi Odinga Oginga Teaching and Referral Ethical review committee for the ethical approval.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
AMPATH	Academic Model Providing Access to Healthcare
ART	Anti Retro Viral Therapy
ARV	Anti Retro Viral
CCC	Comprehensive Care Centre
CD4	Cluster of Differentiation four
CDC	Centre for Disease Control and Prevention
DNA	Deoxyribonucleic Acid
DsDNA	Double stranded Di-ribonucleic Acid
GP 120	Glycoprotein one hundred and twenty
HAART	Highly Active Anti Retro Viral Therapy
HBP	High Blood Pressure
HIV	Human Immune Deficiency Virus
IRIS	Immune Reconstitution Inflammatory Syndrome
KAIS	Kenya Aids Indicator Survey

KASF	Kenya Aids Strategic Framework
KDHS	Kenya Demographic Health Survey
KEMRI	Kenya Medical Research Institution
MALT	Mucosal Associated Lymphoid Tissue
NACC	National Aids Control Council
NASCOP	National AIDs and STIs Control Programme
NERC	National Ethical Review Committee
NGO	Non-governmental organization
NNRTI	Non-Nucleoside Reverse Transcriptase Inhibitors
NRTI	Nucleoside Reverse Transcriptase Inhibitors
OI	Opportunistic Infections
PI	Protease Inhibitors
PMTCT	Prevention of Mother to Child Transmission
RNA	Ribonucleic Acid
SPSS	Statistical Package for the Social Sciences
TDF	Tenofovir Disoproil Fumarate

UN	United Nations
UNAIDS	The Joint United Nations Programme on HIV/AIDS
VL	Viral Load
WHO	World Health Organization

ABSTRACT

In Kenya, KHDS survey observed that approximately 1.43 million people live with HIV with over 77 % receiving ART while 73% achieving viral suppression. The specific objectives were to determine the profiles of clinical predictors of treatment failure among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya. To explore the co-morbidities associated with HIV infection among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya. To assess patient-related factors influencing treatment failure among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya. The gaps in achieving 90:90:90 indicates the dangers of non-suppression (treatment failure) and the consequent socio-economic effects of viral non-suppressions. Due to the contextual gaps in studies examining first – line treatment failure, the study examined the factors determining the treatment failure among HIV positive clients attending Webuye sub-county hospital, Bungoma County, Kenya. The study employed a retrospective cross-sectional design and targeted a total of 3,231 adults who have been active on ART for more than six months. The inclusion criteria were that the clients were adult who had two viral loads test over the last 6 months while excluding patient younger than 18 years those defaulted on ART and too ill to participate. The study had a sample size of 356 clients selected through a formula, The sample size was determined by Yamane (1967), recommended formula of calculating the desired sample size as stated below, when the target population is less than 10,000 and used Simple random sampling to select the participants through the use of random numbers. The study used a document review tool to capture the clients' data which was entered into a excel sheet before being transferred to a statistical package software (SPSS 22.0). The data was analysed descriptively and information presented in tabular and pictographic formats. The study used logistic regression analysis to assess the strength of the relationship between the variables at 0.05 significant levels, and chi-square statistics were utilized to investigate the nature of the relationship between the variables. The study measured treatment failure through successive virological load measures ≥ 1,000 copies/mL in between 3 – 6 months of tests. The results indicated that 4.5 per cent of the participants had first – line treatment failure. Age and sex of participant were found to be significant client-related factors through the chi-square test. while first – line ART regimen, time on ART drug adherence and WHO stage 3 were the clinical – related factors. Presence of opportunistic infections were related to treatment outcomes with alcohol consumption. The logistic regression indicated that client – related factors such as being male increases the likelihood of a treatment failure by 0.1065 while being aged 35 years and below odds ratio increases by 0.6015. The most significant clinical factors were WHO stage, Time on ART and drug adherence. A client with WHO stage 3 or 4 increase the odds ratio by 2.04399, CD4 count < 350 cells increase the odds ratio by 0.4498 while being ART is less than 10 years increases the odds ratio by 0.3960. Lastly, poor drug adherence increases the odds ratio by 4.1919. The presence of comorbidities (opportunistic infections) increased the odds ratio by 5.48079 (presence of tuberculosis) and 3.0320 (presence of diabetes). The study conclusion indicates that client- related and clinical – related factors significantly determine treatment failure among PLHIV in Webuye Sub-county while comorbidities was also a significant issue in treatment failure.

CHAPTER ONE

INTRODUCTION

1.1 Overview

About 28% of the 38 million HIV/AIDS-positive individuals living in the world in 2019 were thought to be based in Eastern and Southern Africa. It was also projected that each year, about 1.7 million people get HIV infection (Zenebe et al., 2020). About 84% of the global population of Adolescent living with HIV live in Sub-Saharan Africa (SSA) with 59% receiving ART. This demonstrates health service gaps due to lack of synchronized healthcare for ALHIV receiving ART (Ferry et al., 2022). KDHS 2023 report observed that approximately 1.43 million people in Kenya are living with HIV with over 96 % of the population being aware of the ARV in the management of ARVs. 80% of the adolescent aged 15 and 19% are knowledge of ARVs compared to over 96% of the individuals aged 40 and 49 years (KNBS, 2022).

1.2 Introduction to the Study

The prevalence of first-line antiretroviral therapy (ART) drug resistance varies across regions. Rhee et al. (2017) conducted a cross-country comparative study revealing that Sub-Saharan Africa had the lowest rate of first-line drug resistance at 2.8%, followed by South/Southeast Asia at 2.9%, other Asian countries at 5.6%, Latin America/Caribbean at 7.6%, Europe at 9.4%, and North America at 11.5%. First-line treatment failure rates range from 11% to 28% globally, with Kyaw et al. (2017) reporting treatment failure rates between 17% and 22% in HIV-positive individuals in Myanmar, leading over 75% of participants to switch to second-line ART regimens.

In high-income Eurozone countries, Beltrán-Pavez et al. (2020) observed a 33.3% virological failure rate among HIV-positive individuals with perinatally acquired infections, with virological failure rates ranging from 14% in Spain to 36% in the Netherlands. Indonesia, Thailand, and Vietnam. Similarly, Ross et al. (2021) found a 41% virological failure rate in Asia, linked primarily to non-nucleoside reverse

transcriptase inhibitors (NNRTIs) at 80%, nucleoside reverse transcriptase inhibitors (NRTIs) at 63%, and protease inhibitors (PIs) at 35%.

Studies from Sub-Saharan Africa show significant gaps in drug resistance and ART outcomes. Crowell et al. (2017) found that 33% of children living with HIV in Mali experienced virologic failure. In Togo, Salou et al. (2016) reported drug resistance rates ranging from 26.8% among those without ART exposure to 65.2% among those exposed to maternal and infant ARVs. In Botswana, Moraka et al. (2021) identified a 22.2% drug resistance rate among infants, with ART regimen resistance rates at 31.8% for NNRTIs, 15.2% for NRTIs, and 5.3% for PIs. Meanwhile, Oluniyi et al. (2022) found a 27.3% drug-resistance mutation rate in HIV-positive individuals in Nigeria.

In East Africa, studies show varying treatment failure rates. Njom Nlend et al. (2017) observed that 17% of children on first-line ART in Cameroon experienced virologic failure, increasing to 20% among those on second-line ART. In Ethiopia, Genet et al. (2021) found a 15.1% treatment failure rate, while Getawa et al. (2021) noted a 12.5% virological failure rate in children after 24 months on ART. Arimide et al. (2022) observed a 21.9% to 24.7% viral load non-suppression rate among female sex workers in Ethiopia. Bayu et al. (2017) found a 28.8% treatment failure rate among HIV-positive individuals in the country. Zenebe et al. (2020) reported a 25.11% incidence of second-line treatment failure in Northern Ethiopia.

In Kenya, Cherutich et al. (2016) reported that 61.2% of people living with HIV (PLHIV) had not achieved virological suppression. Tanyi et al. (2021) observed a virologic failure rate of 25.8% among children and adolescents in Homa Bay County, Kenya. In Uganda, Nasuuna et al. (2018) found a 16% treatment failure rate among children on ART, with no gender differences. Natukunda et al. (2019) reported that only 29% of adolescents achieved viral load suppression, with 71% of those who failed showing poor adherence to ART.

Globally, adolescents remain disproportionately affected by HIV treatment challenges. The World Health Organization (WHO) estimates that adolescents account for one-seventh of new HIV infections, with high levels of non-adherence to ART. In Kenya, recent data from the National Syndemic Disease Council (2023) shows a 78.2%

decline in new HIV infections and a reduction in mother-to-child transmission from 14% to 8.6% over the past decade. However, adolescents and young people aged 15–34 years contribute to 75% of new adult infections. The HIV pandemic remains concentrated in 22 Kenyan counties, with hotspots in Uasin Gishu, Mandera, Bungoma, and Samburu. According to NASCOP (2022), 1.5 million people in Kenya are living with HIV, with over 1.1 million on ART.

1.3 Statement of the Problem

In sub-Saharan Africa, just 29% of HIV-positive individuals have successfully suppressed their virus (Desalegn et al., 2021). Antiretroviral therapy (ART) has become more widely available in resource-constrained Sub-Saharan African nations, but individual monitoring is still not up to par (Villabona-Arenas et al., 2016). The estimated 2.9 million people who were virally suppressed made up only roughly half (49%) of all HIV-positive individuals in the region due to gaps in diagnosis and connecting them to treatment and care (UNAIDS 2019. The Syndromic report by the NASCOP indicate that Bungoma County is one of the hotspots for the rise in HIV infections. The higher rates of the drug resistance and virologic failures indicates the need for targeted interventions to improve ART access and virological monitoring to maximize the benefit of ART (Arimide et al., 2022).

The ability of ART to prevent multiple regimen failure and mortality in clinical practice remains poorly defined and there has not been much research done on how much patients who have failed a first regimen are at risk of failing again (Deeks et al., 2019). Little is known about the exact level of treatment failure and the predictors of ART treatment failure in resource limited settings. There are few research reports about treatment failure of ART among clients on HAART in Kenya. Also, the roles of socio- demographic characteristic, psychosocial factors among others as predicators of treatment failure have produced largely inconsistent results. Due to the gaps in the local studies highlighting the levels of treatment failure, the study evaluates the factors determining first – line treatment failure in Webuye Sub- County Bungoma County.

1.4 Justification

Empirical findings indicate that first - line treatment failure arises from the drug resistance which tends to increase after patient shifted second line ART (NNRTIs 65.5%, NRTIs, 53.3%, PIs 1.1%) (Wang et al., 2015). In developing nations, second line antiretroviral therapy is very expensive with the annual cost of second-line antiretroviral therapy (ART) being 24% higher than that of first-line (Mascolini, 2013).

Preventing HIV drug resistance and maintaining the efficacy of first-line therapy depend on the early detection of treatment failure. Treatment failure is often associated with mortality, which is expensive at the local level, and the emergence of viral strains that are resistant to drugs, which has worldwide ramifications (Assemie et al., 2019).

Health systems worldwide are overstretched by the increasing numbers of individuals seeking access to ART. Specifically, 2 million people in Sub-Saharan Africa (SSA) will be receiving second-line ART by 2030. The overall number of patients receiving ART is expected to stay unchanged, but the percentage of patients receiving second-line ART will rise to 0·8–4·6 million (6·6%– 19·6%). As stated by Estill (2016). First-line treatment failure enhances drug toxicity and drug resistance which are associated with high risk to transmission of drug resistant virus, increase in treatment complexity, worsening morbidity and mortality in HIV/AIDS adults (Enderis et al., 2019)

WHO 2016 guidelines state that everyone living with HIV, regardless of disease stage, should receive treatment. The attempts to increase ART adherence among PLHIV in SSA have been hindered by a lack of funding for efficient HIV services (Ferry et al., 2022). In most resource – limited nations, access to ART is still a challenge and this impedes the sustainability of the sustainability of effective ART (Crowell et al., 2017). Despite the significant progress in scaling up antiretroviral therapy (ART) in sub-Saharan Africa, several challenges still remaining that the identification and management of patients who have failed first-line ART therapy (Harries et al., 2017).

The knowledge gained in this study will help in making recommendations regarding development of appropriate health education strategies to empower clients about what can cause treatment failure. It will also help the ART planners and implementers of ART in reviewing the ART guideline so as to make the necessary changes regarding antiretroviral therapy from the individual, community to national levels.

1.5 Study Objectives

1.5.1 Broad Objective

To determine the predictors of treatment failure among HIV positive clients attending Webuye sub-county hospital, Bungoma County, Kenya.

1.5.1 Specific Objectives

1. To determine the profiles of clinical predictors of treatment failure among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya.
2. To explore the co-morbidities associated with HIV infection among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya.
3. To assess patient-related factors influencing treatment failure among HIV positive clients attending Webuye sub-county Hospital, Bungoma County, Kenya.

1.6 Research Questions

1. What are the profiles of clinical predictors of treatment failure among HIV positive clients attending Webuye sub county Hospital, Bungoma County, Kenya?
2. What are the co-morbidities associated with HIV infection among HIV positive clients attending Webuye sub county Hospital, Bungoma County, Kenya?
3. What is the patient-related factors influencing treatment failure among HIV positive clients attending Webuye sub county Hospital, Bungoma County, Kenya?

1.7 Conceptual Framework

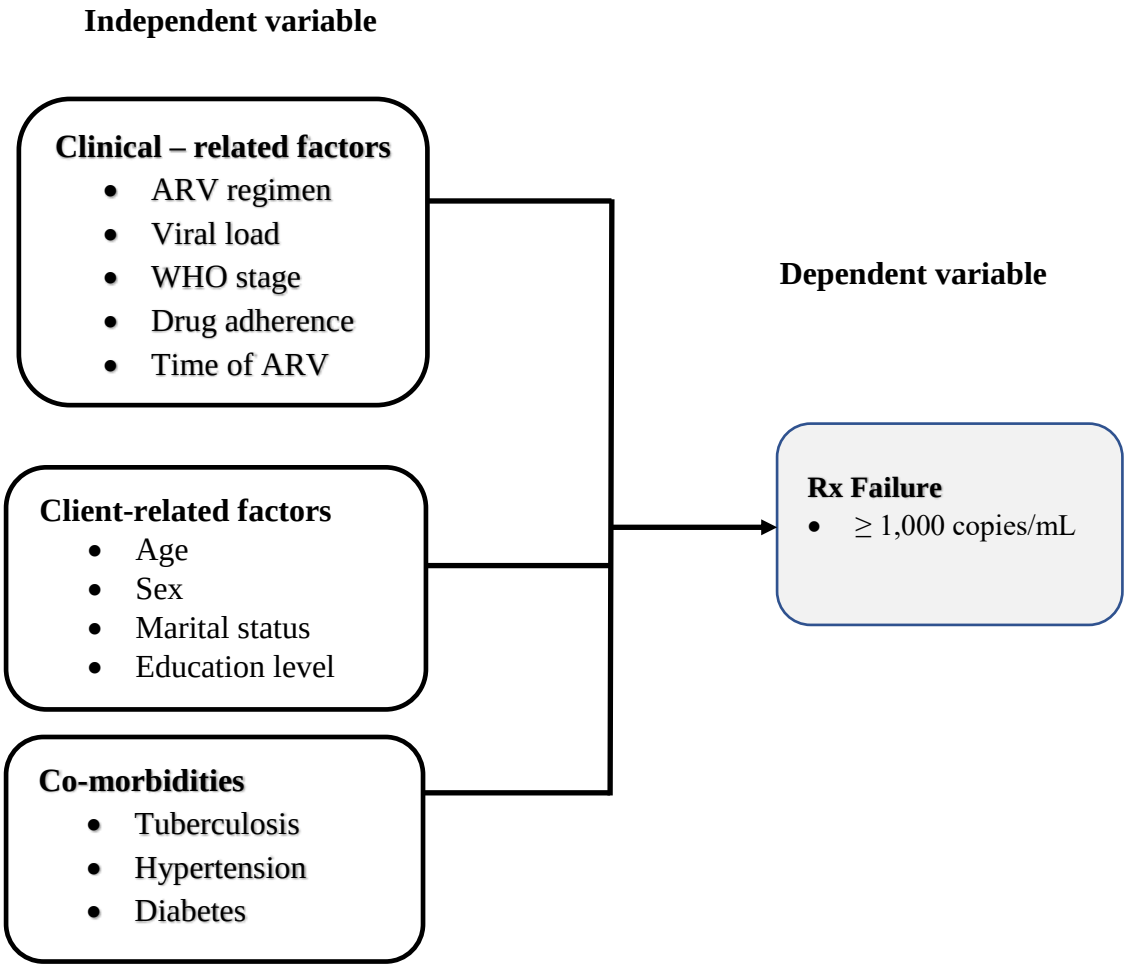

Figure 1.1: Conceptual Framework

Source: Researcher (2018)

CHAPTER TWO

LITERATURE REVIEW

2.1 Antiretroviral Therapy

The WHO guidelines recommend the ART initiation for all adults with HIV and a CD4 count at or below 500 cells/mm^3 and prioritization for those with severe or advanced HIV disease (WHO clinical stage 3 or 4) or a CD4 cell count at or below 350 cells/mm^3 (WHO, 2016). The ART are taken combination of three or more antiretroviral drugs from different classes such as: entry inhibitors, nucleoside and non-nucleoside analogue inhibitors of reverse transcriptase, integrase inhibitors, and protease inhibitors, either taken individually or in fixed-dose combinations for the treatment of HIV (Zenebe et al., 2020).

In general, there are three different ART regimens that are combined: nucleos(t)ide reverse transcriptase inhibitors (NRTIs), protease inhibitors (PI), and non-nucleos(t)ide reverse transcriptase inhibitors (NNRTIs). The five approved NNRTIs include delavirdine (DLV), doravirine (DOR), efavirenz (EFV), etravirine (ETR), nevirapine (NVP), and rilpivirine (RPV), while the approved protease inhibitors (PIs) include atazanavir (ATV), ATV/cobicistat (ATV/c), darunavir (DRV), darunavir/cobicistat (DRV/c), fosamprenavir (FPV), indinavir (IDV), lopinavir/ritonavir (LPV/r), nelfinavir (NFV), ritonavir (RTV), saquinavir (SQV), and tipranavir (TPV) (OAR, 2023). WHO guidelines recommend two NRTIs and dolutegravir as the preferred second-line regimen (Ross et al., 2021).

In Eurozone, the most common ART regimes are made of NRTIs (ABC, 3TC, FTC and TDF) NNRTIs (EVF and RPV) and protease inhibitors (DRV/r, LPV/r, and ATV/r) (Pimentel et al., 2020). In the USA, the approved nucleos(t)ide reverse transcriptase inhibitors (NRTIs) include abacavir (ABC), tenofovir disoproxil fumarate (TDF), tenofovir alafenamide (TAF), lamivudine (3TC), and emtricitabine (FTC). However, older NRTIs (zidovudine (ZDV), stavudine (d4T), didanosine (ddI)) are no longer recommended for use in clinical because of high rates of serious toxicities (OAR, 2023).

The first line ART regimens for adults, pregnant or breastfeeding women, adolescents is usually, tenofovir (TDF) + lamivudine (3TC) or emtricitabine (FTC) + efavirenz (EFV), for children less than 10 years abacavir (ABC) + lamivudine (3TC) + efavirenz (EFV), while for toddlers, abacavir (ABC) or zidovudine (AZT) + lamivudine (3TC) + lopinavir (LPV)/ ritonavir(r) (WHO, 2016). The other alternative ART include dolutegravir (DTG) and nevirapine (NVP) that are used as the third alternative drug in the regimen. The TDF + 3TC (or FTC) + EFV regime is less frequently associated with severe adverse events and has a better virological and treatment response (WHO, 2016). First-line antiretroviral treatment is a combination of two nucleoside reverse-transcriptase inhibitors plus a non-nucleoside reverse-transcriptase inhibitor (Assemie et al., 2019).

The UNAIDS set a 90-90-90 Targets where countries are to identify 90% of HIV-infected persons through testing, ensure ART access to 90% of HIV - infected people, and achieve a 90% viral suppression by 2020 (Ferrand et al., 2017). The WHO guidelines recommend the ART initiation for all adults with HIV and a CD4 count at or below 500 cells/mm^3 and prioritization for those with severe or advanced HIV disease (WHO clinical stage 3 or 4) or a CD4 cell count at or below 350 cells/mm^3 (WHO, 2016).

The availability of ART has dramatically improved survival rates and lowered the incidence of opportunistic infections in people with HIV. ART prevent HIV from multiplying rapidly, and at the same time, boost the body's immune system and increase the quality of life (Zenebe et al., 2020). The global uptake of ART has resulted in significant reductions in HIV-1 mortality, lower mother-to-child transmission, and adult HIV-1 incidence (Rhee et al., 2017). ART is supposed to reduce viral replication with the aim of reducing a patient's VL to undetectable level and thus all individuals are eligible for ART irrespective of their CD4 count (NASCOP, 2022).

Successful treatment of adolescent and children living with HIV requires continuous adherence to the antiretroviral therapy (ART) in order to support viral suppression, stabilize the immunity system and prevent any opportunistic infections (Tanyi et al., 2021). Newman, et al., (2019) examined the treatment failure in children on treatment

for not less than six months using a retrospective cohort study design. In resource-constrained settings, the study discovered that clinical measurements and CD4 cell count have limited predictive value in predicting virological failure in children living with HIV receiving antiretroviral therapy.

Adherence to medication therapy (ART) that is consistent and nearly perfect is deemed necessary for HIV positive patients to fully realize its life extending benefits (Michael et al., 2013). Any levels of adherence below 95% have been associated with poor suppression of HIV viral load and a lowering of CD_4 count leading to disease progression and development of drug resistance. Poor adherence to treatment can also lead to increased drug resistance. Drug resistance monitoring tests are not routinely performed in Kenya, so assessing levels of drug resistance in the country is difficult. In a recent study sample transmitted drug resistance of at least one type was recorded in 9.2% of cases (Onywera et al., 2017).

HIV infection worsens after starting antiretroviral therapy (ART) due to treatment failure. According to Assemie et al. (2019), failure can be classified as clinical, immunologic, virologic, or a combination of these according to WHO criteria. According to Haile et al. (2016), treatment failure is the continuation of the disease after starting antiretroviral therapy. According to Ldous and Haubrich (2009), treatment failure can manifest as clinical, immunologic, or virologic failure, occurring singly or in combination. Even when their level of retroviral RNA copies per milliliter of blood is marginally above the detection threshold, people with HIV are more likely to experience virologic failure than previously believed (Laprise et al, 2013). Owing to a higher frequency of side effects and a higher chance of developing drug resistance and treatment fatigue from prolonged treatment, patients who had previously failed on first-line drugs were 46% more likely to fail on second-line drugs. To maintain the efficacy of first-line therapy, early detection of treatment failure is essential (Kazooba et al., 2018).

Treatment failure in clinical practice, appears to be a common cause of mortality. Studies have reported that those with multidrug failure or multidrug resistance have an overall poor prognosis (Deeks et al., 2019). Clinical and immunological monitoring of

HIV are insensitive and poor predictors of virological failure (Newman et al., 2019). When a patient's viral load (VL) is more than 1,000 copies/ml after at least six months of antiretroviral therapy (ART), treatment failure is suspected and confirmed only when VL remains high after factors such as poor adherence are evaluated and addressed, and after at least three months of excellent adherence, VL is repeated to allow for viral re-suppression (NASCOP, 2022).

Due to the low genetic barrier to resistance of NNRTI-based regimens, the long-term efficacy of ARV treatment is limited in low- and middle-income countries (LMICs). A fixed-dose NRTI/NNRTI combination treatment failure rate for ARV is between 10% and 30% of the HIV-positive population (Rhee et al., 2017). The long-term ART without virological monitoring clearly leads to the accumulation of mutations and the emergence of additional variations, which limit drug options for treatment and can be transmitted. Improved monitoring and optimization of ART are necessary for the long-term effectiveness of ART (Villabona-Arenas et al., 2016).

Individuals who acquire NRTI and/or NNRTI resistance tend to have virological failure acquire and as the number of patients with acquired ARV resistance increases, the proportion of newly infected patients with transmitted drug resistance (TDR) also increases (Rhee et al., 2017). TDR rapidly reverse the effectiveness of first-line ARV therapy at the population level in that individual with TDR who begin ARV therapy with a lower genetic barrier to resistance have a higher risk of virological failure (McMahon et al., 2016).

An endemic TDR strains emanating from a single instance of ARV-selection pressure spreading among many individuals have different public health implications from TDR strains emanating from multiple independent episodes of ARV-selection pressure (Phillips et al., 2016). Endemic strains may carry a greater risk of ongoing transmission reflecting their ability to persist in a population in the absence of selective drug pressure. In contrast, increasing TDR resulting from multiple separate episodes of ARV-selection pressure can be mitigated by reducing the risk of virological failure in patients on therapy (Shroufi et al., 2019).

Table 2.1: PLHIV Statistics by Gender

Year	National statistics		Bungoma County	
	Male	Female	Male	Female
2018	29.25	70.75	27.21	72.79
2019	30.43	69.57	28.57	71.43
2020	28.58	71.42	26.27	73.73
2021	28.37	71.63	24.77	75.23
2022	29.44	70.56	26.47	73.53
2023	30.22	69.78	26.64	73.36
Average	**29.38**	**70.62**	**26.66**	**73.35**

Source: NASCOP (2023) https://viralload.nascop.org/

The distribution in Table 1.1 shows that female patients average seventh tenths of PLHIV at national levels while the number increases to an approximate three quarters in Bungoma County.

Table 2.2: Annual Viral Load Statistics

Year	LDL (≤ 400 copies/mL)		LVL (401 - 999 copies/mL)		HDL (≥ 1,000 copies/mL)		Suppression rates	
	National	Bungoma	National	Bungoma	National	Bungoma	National	Bungoma
2018	76.9	80.3	9.5	4.1	13.7	15.6	87.3	84.4
2019	85.3	83.7	4.9	6.1	9.9	10.1	89.9	89.9
2020	89.6	90.8	2.9	2.4	7.5	6.9	92.5	93.1
2021	91.6	86.3	2.7	5.5	5.7	8.2	94.3	91.8
2022	92.1	88.6	2.3	4.4	5.7	6.9	94.3	93.1
2023	93.1	92.9	2.0	1.5	5.0	5.6	95.0	94.4

Source: NASCOP (2023) https://viralload.nascop.org/

As indicated by Table 1.2, the national averages for viral load non-suppression has gradually reduced from 13.7 % in 2018 to 5.0 % as at August 2023. Comparative, the viral load non-suppression in Bungoma County has reduced from 15.6 % in 2018 to 5.6 % as at August 2023. The figures show a comparatively higher statistics for the county than the national average. The suppression rates for the national have gradually risen from the 87.3 % in 2018 to 95.0 % which is well above the 90-90-90 target for treatment and the national 95.0% target for the management of HIV/AIDS in Kenya.

The suppression rates for the Bungoma County have gradually risen from 84.4 % in 2018 but are well below the national target of 95%.

Table 2.3: National Viral Load Statistics by Gender

Year	LDL (≤ 400 copies/mL)		LLV (401 - 999 copies/mL)		Non – Suppression (≥ 1,000 copies/ml	
	Male	Female	Male	Female	Male	Female
2018	76.99	76.30	10.33	9.00	13.56	11.09
2019	85.61	87.68	5.36	4.34	9.04	7.98
2020	89.87	91.34	3.16	2.54	6.96	6.12
2021	91.39	92.85	2.88	2.41	5.74	4.74
2022	91.48	93.04	2.53	2.01	5.99	4.95
2023	92.47	93.91	2.24	1.73	5.28	4.36

Source: NASCOP (2023) https://viralload.nascop.org/

As shown in Table 1.3, the non – suppression rate for the male patients are comparative higher than their female counterparts in all years. In all the viral load statistics, female patients are more likely to have lower viral load in all the levels and have persistently lower levels of viremia, than their male counterparts.

Table 2.4: Annual Viral Load Confirmatory Statistics

Year	Repeated VL (Treatment Failure)		Single Drug Substitutions		(Clinical Failure /PLLV/No Data)		Routine VL	
	National	Bungoma	National	Bungoma	National	Bungoma	National	Bungoma
2018	5.4	6.8	1.3	1.1	0.8	0.7	91.4	90.8
2019	5.6	9.4	5.4	8.3	1.1	0.1	86.0	81.2
2020	4.7	8.7	2.3	0.8	1.0	0.2	91.4	90.3
2021	3.3	7.0	2.9	0.7	0.5	0.1	93.0	92.2
2022	2.3	3.9	0.6	0.2	0.2	0.3	96.7	95.5
2023	2.9	5.7			0.5	0.3	96.1	93.8

Source: NASCOP (2023) https://viralload.nascop.org/

As shown in Table 1.4, the treatment failure rates at national level have gradually declined from as higher as 5.6% to 2.9% in 2023 while the treatment failure rates in Bungoma County has fluctuated between 5.7% and 9.4%. The single drug substitution is averaging 3 % nationally and 1% in Bungoma County with the notable exception of

year 2019. The statistics for clinical failure rates/ persistent low- levels of viremia and lack of data are below 0.5 per cent.

Table 2.5 County Viral Load Statistics by Gender

Year	LDL (≤ 400 copies/mL)		LLV (401 - 999 copies/mL)		Non – Suppression (≥ 1,000 copies/mL)	
	Male	Female	Male	Female	Male	Female
2018	91.35	81.45	1.79	3.97	6.86	14.58
2019	81.34	84.70	6.68	5.92	11.99	9.39
2020	89.53	91.23	2.72	2.23	7.75	6.54
2021	83.02	87.37	7.08	4.93	9.90	7.71
2022	86.14	89.55	5.02	4.19	8.84	6.26
2023	91.35	93.42	1.79	1.39	6.86	5.19

Source: NASCOP (2023) https://viralload.nascop.org/

Table 1.4 show the county viral load statistics show that male patients have higher viral non-suppression rates well above 7% than the female patients whose statistics are consistently declining annually from as high as 14.58% in 2018 to 5.19 % in 2023. Female patients tend to have low levels of viremia (≤ 400 copies/mL) than their male counterparts

According to (Kenya HIV County profiles, 2016) Bungoma County contributed 2.0% of the total number of people living with HIV in Kenya, and is ranked the fourteenth highest nationally. Overall, Bungoma County has an ART coverage of 93% and the County needs more improvement in the cascade of care to achieve the unmet gaps of 90:90:90 in identification, linkage, and viral suppression (NASCOP, 2016). Therefore, the current study examined the predictors of treatment failure among HIV positive patients in Webuye Sub-County. Bungoma County, Kenya

2.2 Virologic Treatment Failure

The magnitude of first-line ART treatment failure differs across the countries and regions depending on clinical, immunological, or virologic diagnostic criteria used. At the individual patient level, a failed ART regimen or HIV drug resistance limits treatment options com-plicates succession of therapy, and puts the patient at increased

risk for drug toxicity. Patients are receiving medications with some adverse effects when they are switched to second-line treatment options (Desalegn et al., 2021).

The most preferred monitoring strategy to identify and validate treatment failure is viral load; if viral load is not regularly available, CD4 count and clinical monitoring should be employed instead. Treatment failure is defined by a persistently detectable viral load exceeding 1000 copies/mL (that is, after beginning a new antiretroviral therapy regimen for at least six months, two consecutive viral load assessments spaced three months apart, with adherence support in between measurements (WHO, 2016). Additionally useful in differentiating between non-adherence and treatment failure is viral load. According to empirical data, 70% of patients on first-line ART have viral suppression following adherence to ART intervention, with non-adherence to ART being the reason for the high viral load in most cases (WHO, 2016).

Plasma viral load greater than 1000 copies/mL determined by two separate measurements of the virus within a three-month period, with adherence assistance after the initial test (Zenebe et al., 2020). The primary applications of vector length (VL) measurements in Sub-Saharan Africa are in treatment failure diagnosis and monitoring, as well as population-level infectivity surveillance (Cherutich et al., 2016). Treatment failure in HIV-infected children in resource-limited nations, estimated to be 26%–50%, due to a combination of related – factors such as poor ART adherence, inadequate drug supply and acquired resistance from maternal ART exposure (Crowell et al., 2017).

Virologic failure is determined as the inability to achieve or maintain suppression of viral replication to HIV-RNA level < 200 copies/mL while drug resistance mutations was detected with the plasma viral load as at least 500 to 1,000 copies/mL (OAR, 2023). Virologic/treatment failure varies from regions to region, country to country depending on the methodological differences and lack of a standardized definition (Matare et al., (2015). Most studies have converged at a standard definition for a virologic failure as viral loads > 1000 copies/mL with a second VL > 1000 copies/mL within 3–6 months (Ross et al., 2021). Virological failure is a more informative

treatment failure, is a common problem that an HIV patient faces after starting treatment (Bayu et al., 2017).

The second – line treatment failure is attributable to increasing age, higher baseline VL, poorer ART adherence and specific second-line ART regimens, such as non-lopinavir and non-atazanavir PI regimens (Ross et al., 2021). The levels of NNRTI and NRTI resistance ranged from 50% to 97% and from 21% to 91%, respectively. Estimates of dual class resistance (NNRTI and NRTI) ranged between 21% and 91% of individuals for whom NNRTI-based first-line ART failed (WHO, 2019). Several NRTI-only regimens have been shown to have higher failure rates than currently preferred ART regimens, (Murphy et al, 2012), patients on NRTI-only regimens had nearly twice the risk of treatment failure over the 2-year follow-up period**.**

Defined by a persistently high viral load 1,000 copies/ml (two viral loads Measured within 3-month interval with adherence support between measurements) after at least 6 months of using ART (NASCOP, 2018). Viral load measurement is the gold standard for monitoring ART treatment response. The Ministry of Health recommends routine viral load testing for all patients on ART. Where routine viral load is not accessible, CD4 count and clinical monitoring should be used to monitor treatment response and identify patients likely to be failing treatment. Suspected treatment failure should be confirmed using viral load testing (NASCOP, 2018).

Persistent low-level viremia (PLLV) in Kenya is characterized by measurable VL (above the LDL value) on two or more consecutive measures, but less than 1,000 copies/ml. These patients need a case management strategy similar to that of patients with VL ≥ 1,000 copies/mL because they are more likely to progress to treatment failure, develop ARV resistance, and pass away (NASCOP, 2022). After three months of excellent adherence, all PLHIV with a detectable VL (any value above LDL) are evaluated for possible viremia, including stepping up adherence support. The VL is then repeated. If the repeat VL is detectable but less than 1,000 copies/ml, switch to an effective regimen if it is ≥ 1,000 copies/ml (NASCOP, 2022).

The most significant variables in Sub-Saharan Africa that affect treatment failure include lack of knowledge on HIV, medication taste, secrecy/HIV stigma, pill burden,

drug toxicity and resistance, clinic-related factors, sickness, strong religious beliefs and missed appointments (Natukunda, et al., 2019). With increasing numbers of PLHIV on ART and longer durations of therapy, first-line treatment failures have become more common, and increasing numbers of PLHIV have initiated second-line ART (Ross et al., 2021). Poor adherence, body mass index (BMI), and low CD4 count have been associated with virologic treatment failure. Virologic failure may also be caused by patient-related factors such as co-morbidities, inter-mitten access to ART, missed clinic appointments, and antiretroviral (ARV) regimen–related factors, such as drug adverse effects, suboptimal virologic potency, pharmacokinetics, food requirements, and among other factors (Desalegn et al., 2021).

Viral Load Algorithm

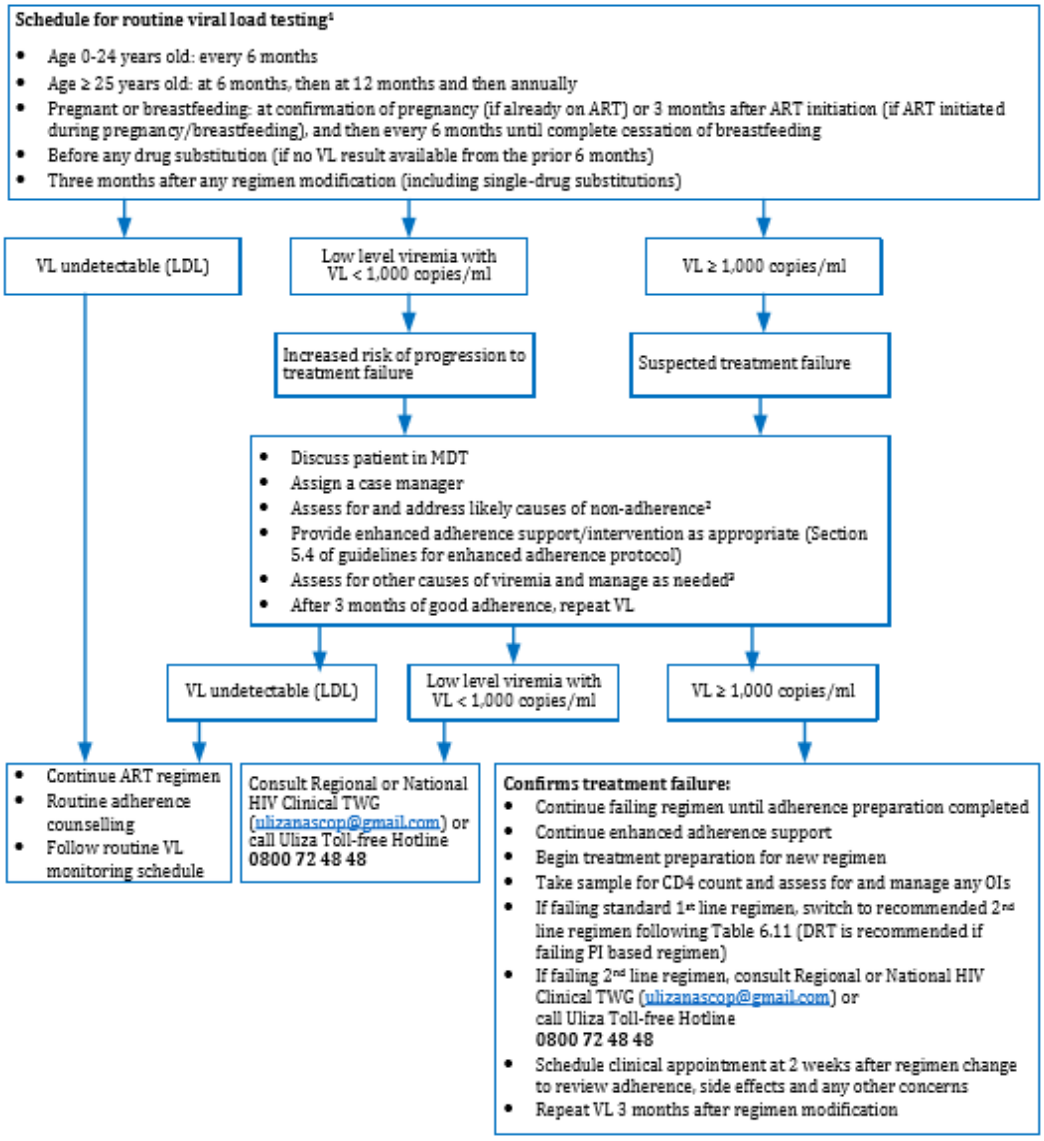

Figure 2.1: Viral Load Algorithm

Source: ART Guidelines 2018, NASCOP

Rutherford et al., (2014) recommends the use of plasma viral load monitoring to detect virologic (treatment) failure and to guide changes in ART regimes. The study validated the viral load criteria of a persistently detectable viral load exceeding 1000 copies/mL. Virologic 'Blips' Clients with an initial low detectable VL (<1000 copies/ml) were

more likely to re-suppress. This may reflect a 'return to mean' phenomenon, or virologic 'blips', rather than indications of poor adherence or resistance. (Lee et al, 2006). Raising the threshold for enhanced adherence counselling and retesting to 1000 copies/ml could avoid unnecessary use of counselling and laboratory resources in this group. However, this must be balanced with the evidence that chronic low-level viremia (100–1000copies/ml) is associated with poorer health outcomes (Laprise et al., 2018).

Numerous factors have been linked to virological failure by studies, including young age, low baseline CD4 count, poor adherence to ART treatment, continuous use of ART since birth, and most recently, lower CD4 count (Bayu et al., 2017). The risk of death was higher for patients who developed drug resistance to HIV during the first year of treatment. Numerous studies have demonstrated that people with poor immune recovery have a higher chance of developing AIDS or passing away (Takuva et al, 2014).

2.3 Immunologic Failure

The WHO guidelines define immunological failure as: the fall off CD4 count to below baseline in the absence of concurrent infections, a fall of more than 50% from the peak value or persistent CD4 below 100 cells/mm^3 while on treatment (Gunda et al., 2017). For all individuals living with HIV, those who may be experiencing treatment failure, patients receiving fluconazole maintenance therapy, or those receiving dapsone as a preventive measure, CD4 monitoring is the baseline investigation (NASCOP, 2022). When starting ART, confirming a pregnancy, prior to changing medications, and three months following a regimen modification, routine VL monitoring via CD4 count is conducted (single-drug substitutions) every six months for person aged between 0 to 24 years and at one month 6, 12, and then annually for individuals for individuals aged 25 years and above (NASCOP, 2022).

The accumulation of HIV-1 drug-resistant mutations (DRMs), which may restrict options for further treatment, is linked to the widespread use of CD4 cell counts rather than routine virological monitoring to diagnose ART failure in resource-constrained settings (Hamers et al., 2015). WHO immunological criteria have low sensitivity and

positive predictive value for detecting treatment failure. Relying on CD4 counts for treatment monitoring would therefore lead to misclassifications of treatment failure that could result into unnecessary or delayed switch to second line ART (Gunda et al., 2017).

It is important for adolescents living with HIV to transition to adult care. When this population reaches adulthood, there are significant obstacles to ensuring long-term virological suppression. Adolescence who perinatally acquired with HIV are exposed to various antiretroviral (ARV) drug regimens during their lifetime and have a higher risk of developing ARV resistance, compromising the success of present and future treatments options.. These individuals tend to have higher mortality and virological failure rates compared to younger children and adults (Beltrán-Pavez et al., 2020).

World Health Organisation recommended routine annual viral load (VL) monitoring for all patients on antiretroviral therapy (ART), as the most accurate available measure of effective treatment response. When a patient has been on antiretroviral therapy (ART) for at least six months, an elevated or "non-suppressed" VL (>1000 copies/ml) may indicate poor adherence to treatment or therapeutic failure brought on by antiretroviral resistance (Jobanputra et al., 2016). The sensitivity of clinical and immunological criteria in identifying treatment failure is low and specificity for diagnosing treatment failure. (NASCOP 2016). If viral load is suppressed and the CD4 cell count is stable, clinical progression is not always an indication that a change of regimen is needed.

CD4 cell count and overall health should also be taken into account when deciding whether to change antiretroviral therapy. CD4 cell counts usually rise when treatment suppresses viral load. When viral replication is slowed or halted, fewer new CD4 cells become infected, allowing the immune system to recover. However, the CD4 cell count usually increases more slowly after viral load starts to decline. It is reasonable to wait a few months after viral load drops to give CD4 cells a chance to rise before declaring immunological treatment failure (Kazooba et al., 2018).

Conversely, a decline in CD4 count may be delayed after viral load rebounds. Studies have shown that a virologically ‘failing’ regimen may continue to provide benefit to

the immune system for months or even years after viral load increases to a detectable level, especially if there was a large reduction in viral load when the regimen was started. One study found that the CD4 count returned to the pre-treatment level an average of three years after virological failure of protease inhibitor-based treatment (Laprise et al., 2018).

In spite of virologic suppression, patients with extremely low baseline CD4 values prior to starting ART are more likely to experience an impaired CD4 response to the treatment and, according to adult studies, may also be more likely to die or develop diseases that define AIDS (Lewis and Walker, 2012). In a study of 933 children aged ≥ 5 years who received ART that resulted in virologic suppression, 92 (9.9%) had CD4 cell counts <200 cells/mm^3 at ART initiation and 348 (37%) had CD4 cell counts <500 cells/mm^3. After 1 year of virologic suppression, only 7 (1% of the cohort) failed to reach a CD4 cell count of at least 200 cells/mm3 and 86% had CD4 cell counts >500 cells/mm^3. AIDS-defining events were uncommon overall (1%) but occurred in children who did and did not achieve improved CD4 cell counts (Palella Jr, et al., 2016).

A patient's risk of drug resistance, viral mutation, and death increases if they have advanced disease at the time of presentation. In spite of virologic suppression, patients with extremely low baseline CD4 values prior to starting ART are more likely to experience an impaired CD4 response to the treatment and, according to adult studies, may also be more likely to die or develop diseases that define AIDS (Lewis & Walker, 2012). In a study of 933 children aged ≥5 years who received ART that resulted in virologic suppression, 92 (9.9%) had CD4 cell counts <200 cells/mm3 at ART initiation and 348 (37%) had CD4 cell counts <500 cells/mm^3. After 1 year of virologic suppression, only 7 (1% of the cohort) failed to reach a CD4 cell count of at least 200 cells/mm^3 and 86% had CD4 cell counts >500 cells/mm^3. AIDS-defining events were uncommon overall (1%) but occurred in children who did and did not achieve improved CD4 cell counts (Chadwick et al, 2008).

2.4 Clinical- Related Factors Influencing Treatment Failure

Children in Uganda infected with HIV-1 were evaluated by Sebunya et al., (2013) for risk factors related to first line treatment failure. Treatment failure was linked to medication non-adherence, according to the findings. This included poor adherence to antiretroviral therapy (ART), a first-line regimen based on NVP, and prior exposure to NVP. Using an observational study, Njom Nlend et al. (2017) evaluated the first line virologic failure among children in Cameroon living with HIV. The study found, using logistic regression, that treatment with stavudine-containing regimens, male gender, and mother lessness are associated with virologic failure.

In western Ethiopia, Desalegn et al., (2021) evaluated the factors associated with adult HIV patients' failure to respond to first-line treatment. The results of the logistic regression analysis showed that the failure of first-line antiretroviral treatment was significantly influenced by factors such as lower CD4 count, lack of support group, poor ART adherence, and ART initiation at an advanced stage. Using a case-control study design, Matare et al., (2015) investigated the variables linked to first-line treatment failure in Zimbabwe. According to the study, baseline CD4 count of less than 50 cells/mm3, drug stock outs, poor adherence to antiretroviral therapy (ART), and baseline WHO Stage 3 or 4 levels were all linked to first-line treatment failure. Patients with poor medication adherence were 16 times more likely to develop virological failure than patients with good adherence, highlighting the importance of ART adherence as a predictor of virological failure (Bayu et al., 2017).

In a country comparative study, Aurpibul et al., (2016) examined the factors determining the treatment failure rate among children in Indonesia, Thailand and Vietnam. Based on regression analysis, the findings indicated that treatment failure was associated with lopinavir concentrations <1.0 mg/L and CD4 <20% at second-line switch, and non-adherence to ART within three days before the HIV-RNA measurement. Based on a control study, Sithole et al., (2018) assessed the risk factors for virological failure in Zimbabwean adolescents receiving antiretroviral therapy. Regression analysis was used to determine the study's findings, which included alcohol

consumption, non-disclosure of HIV status, and non-adherence to ART as risk factors for virological failure.

Kyaw et al., (2017) examined the variables influencing first-line treatment failure in HIV-positive individuals residing in Myanmar. Based on regression analysis, the findings indicate that virological failure is associated with: having WHO stage 3 and 4 at ART initiation, young age < 24 years, non-adherence to ART treatment. Using a retrospective study design, Zenebe et al., (2020) investigated the factors linked to second-line treatment failure among HIV-positive individuals living in Northern Ethiopia. The results showed that treatment failure was linked to age > 45, poor ART adherence, WHO stage IV, and CD4 count <100 cells/mm3 at the beginning of second-line ART based on the Cox proportional hazard model.

Salou et al., (2016) reported that drug resistance among children was associated with the use of Nucleoside reverse transcriptase inhibitor therapies. Crowell et al., (2017) examined the factors determining virologic failure among children living with HIV in Mali based on a baseline study. Based on regression analysis, the findings indicated that first line virologic failure was attributed to non- adherence to the ART and the use of NNRTI-based ART regimes (Nevirapine). A longitudinal study on transferred patients in Spain attributed virologic failure to partial adherence to treatment (Beltrán-Pavez et al., 2020).

Certain ARV agents or combinations may be associated with a blunted CD4 response. For example, treatment with a regimen containing Tenofovir Disoproxil Fumarate (TDF) and didanosine can blunt the CD4 response, especially if the didanosine dose is not reduced (Zheng et al., 2014), this combination is not recommended. If co-administration is unavoidable, dosing of didanosine should be reduced when co-administered with TDF. In adults, ARV regimens containing zidovudine may also impair rise in CD4 cell count but not CD4 percentage, perhaps through the myelo suppressive effects of zidovudine (Takuva et al., 2014). Fortunately, this ARV drug-related, suboptimal CD4 cell count response to therapy does not seem to confer an increased risk of clinical events. It is not clear whether this scenario warrants substitution of zidovudine with another drug. Patients who are classified as WHO IV

due to co-morbidity advanced opportunistic disease may experience drug interactions between OI treatment and ART, potentially impairing their immunity even further. This could have a detrimental effect on how they react to treatment after switching.

Murray, Elashoff, Iacono-Connors, Cvetkovich, and Struble, (2005) conducted a study in the United States that identified factors associated with virologic failure. The study found that non-adherence, substance use, and prior antiretroviral therapy (ART) experience were major factors in treatment failure among HIV-infected individuals.

Petti, García-Leoni, Rendo, Perez and Cahn (2010) in Argentina investigated the factors influencing ART failure in HIV-infected adults. The study showed that poor adherence to therapy, late initiation of ART, and lower CD4 counts at baseline were predictors of treatment failure.

2.4 Patient–Related Factors Influencing Treatment Failure

Tanyi et al., (2021) examined the factors affecting adherence to treatment among adolescents living with HIV in Homa Bay County Kenya using a retrospective study. Based on logistic regression, the study observed that education levels had no significant effect on the viral suppression while Enhanced Adherence Counselling (EAC) were significant predictors of viral suppression. Pimentel et al., (2020) examined the drug resistance among migrants followed up in Portugal using a baseline study. Based on regression analysis, the study observed that drug resistance was associated with age, subtype B, and viral load.

In a study carried out in Uganda, Natukunda., et al., (2019) examined the factors influencing treatment failure among HIV-positive adolescents. The study indicated treatment failure was related to having a history of treatment failure, religious (being Anglican) and seeking religious intervention for treating and managing HIV-AIDS. Cherutich et al., (2016) examined the probability of treatment failure using a national survey data in Kenya. Based on regression analysis, the findings observed that younger age, and lack of awareness of HIV status and sub-optimal ART usage were associated with significantly higher odds of virologic failure. Using a randomized controlled trial, Ferrand et al., (2017) investigated the rate of treatment failure among HIV-positive

children and adolescents in Zimbabwe. The results showed that the rate of treatment failure and mortality was influenced by age and lower income status.

Njom Nlend et al., (2017) assessed the first line virologic failure among children living with HIV in Cameroon using an observational study. Based on logistic regression, the study established that virologic failure is associated with male gender, orphanhood (Motherless) and treatment with stavudine-containing regimens. Based on regression analysis, Arimide et al., (2022) observed that VLN among female sex workers in Ethiopia was associated with age ≤ 35 years and forced sexual encounters.

Jobanputra et al., (2016) examined the factors determining virologic failure among people living with HIV in Swaziland. Based on regression analysis, the key predictors of virologic failure were: being an adolescent or a child, longer time on ART, WHO Clinical Stages 3 and 4, and recent CD4 <350 cells/μL. Bayu et al., (2017) examined the virologic failure among people living with HIV in Ethiopia using baseline survey. The study used regression analysis and the finding indicated that poor adherence to treatment, longer exposure to ART, younger age < 35 years and with CD4 count <200 cells/mm^3 were positively associated with virological treatment failure.

Using a cross-sectional design, Ross et al. (2021) investigated second-line treatment failure among HIV-positive individuals in Asia Pacific. Using logistic regression analysis, the study's conclusions demonstrated a correlation between treatment failure and injectable drug use, male-to-male sex interactions, and a CD4 count greater than 200 cells/μL at the beginning of the intervention. Using a cross-sectional study, Genet et al., (2021) assessed the factors influencing first-line treatment failure in Ethiopia. Using logistic regression, the research showed that treatment failure was associated with male gender, poor adherence to ART regime, irregular time of drug intake, multiple sexual partners, and CD4 counts <200 cells/mL.

HIV-infection is a very stigmatized chronic disease with increased rates of psychiatric disorders and depression as the most common occurrences (Marinho et al., 2016). Many adverse health-related behaviours emerge or augment during adolescence. These behaviours, such as smoking, poor diet, physical inactivity, excessive alcohol consumption, risky sexual behaviours and illicit drug use, are relatively persistent

during life. They highly contribute to morbidity and mortality among adults (Kazooba et al., 2018).

Patients' factors like gender, age, level of education, immunity and social support are important in determining whether treatment will succeed or fail (Kazooba et al., 2018). The most frequent cause of treatment failure is non-adherence, which carries a risk of developing drug resistance due to inadequate viral suppression. The need for second-line treatment rises when first-line ART-resistant HIV strains spread further; this is frequently linked to worse patient outcomes and higher healthcare expenses. High prevalence of tobacco use and low success in quitting remain significant problems for reducing disease burden among HIV-infected persons (Browning et al., 2016).

The prevalence of cigarette smoking among persons living with HIV/AIDS (PLWHA) is approximately 40%, significantly higher than that of the general population. Identifying predictors of successful smoking cessation for PLWHA is necessary to alleviate the morbidity and mortality associated with smoking in this population. In the general population, weight gain has been linked to smoking relapse (Buchberg et al., 2016). According to Hile et al., (2016), smoking tobacco is linked to a number of unfavourable health outcomes for people living with HIV (PLHIV), including an increased risk of cancer and cardiovascular issues. HIV-positive smokers who smoke have higher rates of morbidity and death (Keith et al., 2016).

Fear of discrimination and/or experiencing stigma were determinants of non-adherence. This included being laughed at, exclusion from activities, being fired and alienation. (Katende-Kyenda, 2018). Age at ART initiation is a risk factor for virological failure is similar to other studies. Increased age may be a marker for greater maturity, lifestyle stability, and disease-specific education; these factors are likely to affect long-term adherence to therapy (Watt et al., 2019). In two studies associated with HAART, adherence non-adherence showed a positive correlation with younger age. However, younger age and poor adherence were both independent risk factors for virological failure (Heestermans et al., 2016).

The same pattern of males being more likely to experience ART treatment failure was observed in a Nigerian study (Anude et al., 2013). Male HIV-positive patients may be

more likely to experience treatment failure, which highlights the need to find the contributing factors and develop specialized treatment plans for this population. Adherence has been demonstrated to be important for clinical cohorts and trial participants, most studies have relied on pill counts, electronic measuring devices, or patient self-reported adherence questionnaires (Zaccarelli et al., 2015).

Missed clinic visits or attendance could surrogate for medication adherence. As previously demonstrated that missed clinic visits during the observation period correlated with worse treatment outcomes in a cohort of primarily non-white patients. The current study differed in that prior missed visits reflected baseline characteristics (Watt et al., 2019). In contrast, missed visits during the observation period were included. Poor adherence and missed visits may reflect patient characteristics that are relatively stable over time, and therefore amenable to disease management interventions (Katende-Kyenda, 2018).

Living alone and lack of support have been associated with an increase in non-adherence and social isolation is predictive of non-adherence (Furtado et al., 2018). Having a partner, social or family support, peer interaction, and better physical interactions and relationships are characteristics of adherent patients. Alcohol use is strongly associated with risky sexual behaviour among people with HIV infection (Heestermans et al., 2016). People using alcohol are less likely to adhere to their antiretroviral medication, they are more likely to have a high virus load, including resistant virus. Therefore, people with HIV who consume significant amounts of alcohol pose a particularly high risk of HIV transmission, and the virus transmitted already may be resistant to at least some forms of ART.

Ross, Chan, Vann and Lee (2021) investigated second-line treatment failure among HIV-positive individuals in Asia Pacific, identifying correlations with injectable drug use, male-to-male sex interactions, and a CD4 count greater than 200 cells/μL at the start of the intervention. Genet et al. (2021) assessed first-line treatment failure in Ethiopia, finding associations with male gender, poor adherence to ART, irregular drug intake, multiple sexual partners, and CD4 counts <200 cells/mL.

Chaiyaporn, Rojanawiwat and Sukkasem (2019) explored factors associated with treatment failure among HIV-positive adults in Thailand, noting significant associations with irregular ART adherence, substance abuse, and low socio-economic status (Chaiyaporn et al., 2019). Sharma et al. (2020) investigated patient-related factors contributing to ART failure in India, finding that stigma, lack of social support, and psychological issues were significant predictors (Sharma et al., 2020).

Lee, Kim and Yoon (2022) conducted a study in South Korea to evaluate the impact of patient adherence on ART failure rates. They identified that non-adherence due to financial constraints and psychiatric disorders were key factors contributing to treatment failure (Lee et al., 2022). Another study by Huang et al. (2023) in China found that barriers such as healthcare access, discrimination, and inconsistent follow-up visits were strongly associated with increased rates of ART treatment failure (Huang et al., 2023).

2.4.1 Relationship with Specific Objectives

Tanyi et al. (2021) examined the factors affecting adherence to treatment among adolescents living with HIV in Homa Bay County, Kenya, using a retrospective study. Based on logistic regression, the study observed that education levels had no significant effect on viral suppression, while Enhanced Adherence Counselling (EAC) were significant predictors of viral suppression. Pimentel et al. (2020) examined drug resistance among migrants followed up in Portugal using a baseline study. Based on regression analysis, the study observed that drug resistance was associated with age, subtype B, and viral load.

In a study carried out in Uganda, Natukunda et al. (2019) examined the factors influencing treatment failure among HIV-positive adolescents. The study indicated that treatment failure was related to having a history of treatment failure, religious (being Anglican), and seeking religious intervention for treating and managing HIV/AIDS. Cherutich et al. (2016) examined the probability of treatment failure using national survey data in Kenya. Based on regression analysis, the findings observed that younger age, lack of awareness of HIV status, and sub-optimal ART usage were associated with significantly higher odds of virologic failure. Using a randomized

controlled trial, Ferrand et al. (2017) investigated the rate of treatment failure among HIV-positive children and adolescents in Zimbabwe. The results showed that the rate of treatment failure and mortality was influenced by age and lower income status.

Njom Nlend et al. (2017) assessed first-line virologic failure among children living with HIV in Cameroon using an observational study. Based on logistic regression, the study established that virologic failure is associated with male gender, orphanhood (Motherless), and treatment with stavudine-containing regimens. Based on regression analysis, Arimide et al. (2022) observed that VLN among female sex workers in Ethiopia was associated with age ≤ 35 years and forced sexual encounters.

Jobanputra et al. (2016) examined the factors determining virologic failure among people living with HIV in Swaziland. Based on regression analysis, the key predictors of virologic failure were being an adolescent or a child, longer time on ART, WHO Clinical Stages 3 and 4, and recent CD4 <350 cells/μL. Bayu et al. (2017) examined virologic failure among people living with HIV in Ethiopia using a baseline survey. The study used regression analysis, and the findings indicated that poor adherence to treatment, longer exposure to ART, younger age < 35 years, and CD4 count <200 cells/mm^3 were positively associated with virological treatment failure.

Ross et al. (2021) investigated second-line treatment failure among HIV-positive individuals in Asia Pacific, identifying correlations with injectable drug use, male-to-male sex interactions, and a CD4 count greater than 200 cells/μL at the start of the intervention. Genet et al. (2021) assessed first-line treatment failure in Ethiopia, finding associations with male gender, poor adherence to ART, irregular drug intake, multiple sexual partners, and CD4 counts <200 cells/mL.

Chaiyaporn et al. (2019) explored factors associated with treatment failure among HIV-positive adults in Thailand, noting significant associations with irregular ART adherence, substance abuse, and low socio-economic status (Chaiyaporn et al., 2019). Sharma et al. (2020) investigated patient-related factors contributing to ART failure in India, finding that stigma, lack of social support, and psychological issues were significant predictors (Sharma et al., 2020). Lee et al. (2022) conducted a study in South Korea to evaluate the impact of patient adherence on ART failure rates. They

identified that non-adherence due to financial constraints and psychiatric disorders were key factors contributing to treatment failure (Lee et al., 2022). Huang et al. (2023) conducted a study in China, finding that barriers such as healthcare access, discrimination, and inconsistent follow-up visits were strongly associated with increased rates of ART treatment failure (Huang et al., 2023).

HIV infection is a highly stigmatized chronic disease with increased rates of psychiatric disorders and depression as common occurrences (Marinho et al., 2016). Many adverse health-related behaviors emerge or augment during adolescence. These behaviors, such as smoking, poor diet, physical inactivity, excessive alcohol consumption, risky sexual behaviors, and illicit drug use, are relatively persistent throughout life and contribute significantly to morbidity and mortality among adults (Kazooba et al., 2018).

Patient-related factors like gender, age, level of education, immunity, and social support are crucial in determining whether treatment will succeed or fail (Kazooba et al., 2018). The most frequent cause of treatment failure is non-adherence, which carries a risk of developing drug resistance due to inadequate viral suppression. The need for second-line treatment rises when first-line ART-resistant HIV strains spread further; this is frequently linked to worse patient outcomes and higher healthcare expenses. High prevalence of tobacco use and low success in quitting remain significant problems for reducing disease burden among HIV-infected persons (Browning et al., 2016).

The prevalence of cigarette smoking among persons living with HIV/AIDS (PLWHA) is approximately 40%, significantly higher than that of the general population. Identifying predictors of successful smoking cessation for PLWHA is necessary to alleviate the morbidity and mortality associated with smoking in this population. In the general population, weight gain has been linked to smoking relapse (Buchberg et al., 2016). According to Hile et al. (2016), smoking tobacco is linked to a number of unfavorable health outcomes for people living with HIV (PLHIV), including an increased risk of cancer and cardiovascular issues. HIV-positive smokers who smoke have higher rates of morbidity and death (Keith et al., 2016).

Fear of discrimination and/or experiencing stigma were determinants of non-adherence. This included being laughed at, exclusion from activities, being fired, and alienation (Katende-Kyenda, 2018). Age at ART initiation is a risk factor for virological failure similar to other studies. Increased age may be a marker for greater maturity, lifestyle stability, and disease-specific education; these factors are likely to affect long-term adherence to therapy (Watt et al., 2019). In two studies associated with HAART, adherence non-adherence showed a positive correlation with younger age. However, younger age and poor adherence were both independent risk factors for virological failure (Heestermans et al., 2016).

The same pattern of males being more likely to experience ART treatment failure was observed in a Nigerian study (Anude et al., 2013). Male HIV-positive patients may be more likely to experience treatment failure, which highlights the need to find the contributing factors and develop specialized treatment plans for this population. Adherence has been demonstrated to be important for clinical cohorts and trial participants; most studies have relied on pill counts, electronic measuring devices, or patient self-reported adherence questionnaires (Zaccarelli et al., 2015).

Missed clinic visits or attendance could surrogate for medication adherence. As previously demonstrated, missed clinic visits during the observation period correlated with worse treatment outcomes in a cohort of primarily non-white patients. The current study differed in that prior missed visits reflected baseline characteristics (Watt et al., 2019). In contrast, missed visits during the observation period were included. Poor adherence and missed visits may reflect patient characteristics that are relatively stable over time and therefore amenable to disease management interventions (Katende-Kyenda, 2018).

Living alone and lack of support have been associated with an increase in non-adherence, and social isolation is predictive of non-adherence (Furtado et al., 2018). Having a partner, social or family support, peer interaction, and better physical interactions and relationships are characteristics of adherent patients. Alcohol use is strongly associated with risky sexual behavior among people with HIV infection (Heestermans et al., 2016). People using alcohol are less likely to adhere to their

antiretroviral medication and are more likely to have a high virus load, including resistant virus. Therefore, people with HIV who consume significant amounts of alcohol pose a particularly high risk of HIV transmission, and the virus transmitted already may be resistant to at least some forms of ART.

2.5 Co-morbidities Associated with HIV Infection

In Indonesia, Subronto et al., (2020) evaluated the factors determining first – line treatment failure among adult patients using logistic regression analysis. The findings indicated that patients with co-morbidities, in particular, tuberculosis and the use of nevirapine as the first – line treatment had a higher risk of treatment failure. A systematic and meta-analytical review was used by Assemie et al., (2019) to determine the prevalence of treatment failure. Co-morbidities, non-disclosure, advanced WHO clinical stage, and poor adherence to ART regimen were found to be significant predictors of treatment failure based on logistic regression analysis.

Enderis et al., (2019) evaluated the predictors of the first -line treatment failure among adult patients living with HIV in Western Ethiopia. Based on the regression analysis, the findings indicated that co-morbidities (opportunistic infection such as tuberculosis), low CD4 count < 200cells/mm^3, poor adherence to the ART, history of substance use, disclosure status, Advance WHO clinical stage, nutritional status and functional status. Low CD4 count**,** poor adherence to ART**, and** history of substance abuse are factors affecting treatment and disease progression but are not classified as comorbidities. Comorbidities would include the opportunistic infections and other chronic conditions mentioned.Getawa et al., (2021) examined the factors determining the first – line treatment failure among children living with HIV in Ethiopia. Based on logistic regression, the findings indicated that male gender, co-morbidities such as tuberculosis infection, ART regimen change, and consistent use of HAART since birth were indicative of the treatment failure. HIV infection and particular ARTs substantially increase the risk for incidence and progression of liver disease.

According to Zenu et al., (2021), adult patients in South-West Ethiopia had a high prevalence of first-line treatment failure. A multivariable logistic regression analysis was used to determine the factors that significantly contributed to the failure of first-

line antiretroviral treatment. These factors included co-morbidities (a history of TB co-infection), advance WHO clinical stages III and IV, baseline body mass index, low baseline CD4 cell count <100cells/mm3, poor adherence to ART, and late ART initiation. Among HIV in Southwest Ethiopia, Bekele Asfaw et al., (2019) assessed the factors associated with first-line ART failure. Based on logistic regression, the findings indicated that first – line treatment failure was determined by co-morbidities (tuberculosis coinfection), zidovudine - based regimen residency in urban environment, substance use (cigarette and Khat), poor treatment adherents, prior exposure and longer duration on ART more than 73 months.

In a randomized trial of late initiation of ART, Naidoo et al., (2014) examined the administration of ART coupled with tuberculosis treatment regime in South Africa. The study observed a first – line treatment failure in 25% of the patients. The treatment failure was associated with tuberculosis and CD4+ cell count <50cells/mm3 and late ART initiation and body mass index > 25 kg/M^2. Treatment failure is associated with treatment limiting toxicities were neuropsychiatric effects, elevated transaminase levels and hyperlactatemia and peripheral neuropathy (Naidoo et al., 2014). When combining TB with HIV treatment, treatment-limiting toxicity is a major concern. Additional issues include immune reconstitution inflammatory syndrome (IRIS), high pill burden, and drug interactions between rifampicin and some classes of antiretrovirals.

An important consideration when integrating TB-HIV treatment is treatment-limiting toxicity. Immune reconstitution inflammatory syndrome (IRIS), high pill burden, and drug interactions between rifampicin and some classes of antiretrovirals are additional concerns. An important consideration when integrating TB-HIV treatment is treatment-limiting toxicity. Immune reconstitution inflammatory syndrome (IRIS), high pill burden, and drug interactions between rifampicin and some classes of antiretrovirals are additional concerns.

HIV and ART have been associated with increased risk of both cardiovascular and cerebrovascular disease> PLWH remain at higher risk for all types of CVD including heart failure, stroke, and arrhythmias in the post-ART era. Chronic inflammation may

play an important role in this increased risk. While HIV-associated cardiomyopathy was reported in 10–40% of HIV+ patients prior to ART, there is a significant reduction in this rate after introduction of ART. This reduction in cardiomyopathy and overt myocarditis (due to HIV or other co-infections) resulted in the initial underestimation of the risk of myocardial involvement and heart failure (HF) in HIV+ patients on ART (Barnes, Lacson & Bahrami, 2017).

The sustained increased heart failure risk despite significant reduction in HIV-associated cardiomyopathy in HIV+ patients on ART can be attributed to other mechanisms involved in pathogenesis of heart failure HIV+ patients continue to have higher rates of traditional risk factors for Cardiovascular heart failure, drug abuse, and CAD. Additionally, HIV+ patients are shown to have higher levels of autonomic dysfunction and inflammation (Barnes, Lacson & Bahrami, 2017).

PLWH are now experiencing more comorbid conditions such non-AIDS-defining cancers, cardiovascular diseases (CVD), renal and liver diseases (Eyawo et al., 2017). HIV infection, through several known mechanisms such as viremia, inflammation, co-infections, and traditional risk factors such as dyslipidemia, smoking, and substance abuse, leads to higher risk of coronary artery disease, microvascular disease, and autonomic/neurohormone dysfunction. Subsequently, these abnormalities along with other unknown mechanisms result in myocardial disease and left ventricular dynamic dysfunction, which in turn give rise to higher risk of heart failure and arrhythmia (Barnes, Lacson & Bahrami, 2017).

It is estimated that 15 to 30% of all HIV-infected persons are also infected with the hepatitis C virus (HCV). The percentage of HIV-infected patients co-infected with HCV was found to vary significantly in previous studies depending on risk factors, from as low as 4% among HIV-infected non-drug users to as high as 89% among HIV-infected injecting drug users (Bedimo et al., 2017). Low levels of liver injury are associated with substantial increases in risk of mortality among patients with HIV infection. These levels of injury are common among HIV-infected patients receiving care due to multiple causes, including alcohol use viral hepatitis, ART toxicity, and, likely, non-antiretroviral medication toxicity. Liver cell injury is increasingly

recognized as a particularly important source of morbidity and mortality among people with HIV, it is largely ascribed to coexisting viral hepatitis and medication-associated liver damage (e.g., antiretroviral drugs) (Farahani et al., 2017).

Those living with HIV have a higher risk of developing bacterial pneumonia and chronic obstructive pulmonary disease than those who are not infected. Alcohol suppresses the immune system by influencing both the innate and adaptive systems. Furthermore, studies indicate a stronger correlation between alcohol consumption and both acute and chronic lung conditions, particularly chronic obstructive pulmonary disease (Backus et al., 2019).

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The study used a retrospective cross-sectional study. In retrospective studies, the outcome of interest has already occurred in each individual by the time s/he is enrolled, and the data are collected either from records. Retrospective studies take an experimental design that assesses events that have already occurred (Ranganathan & Aggarwal, 2018). The researcher collected data that were previously recorded for reasons not relating to the project. This data related to the patients visits to the health facility for the management and prevention of HIV/AIDS.

3.2 Study Site

The study was carried out in Webuye sub-county hospital which was started in 1990 through funding from the East African Development Bank with support from the Chinese government Una program. It began as a dispensary in 1992. The hospital has a bed capacity of 217 with approximately 150% bed occupancy rates. On a daily basis, between 150-200 patients suffering from diverse conditions can be attended to. The theatre operates on between 125 and 145 patients per month and has two general surgeons and six specialized ones. The hospital partners with several NGO's and other organizations such as the UN through AMPATH, offering family and public health care, the family medicine department of Moi University, which carries out research on Burkett's lymphoma, and Moi Teaching and Referral Hospital on cervical cancer.

The hospital also collaborates with Kenya medical training college (KMTC) offering a vast range of courses such as nursing, Health Records with Information systems and clinical medicine studies. Students gain experience from attachment at various departments at the hospital. It has diverse departments, both medical and non-medical. They include inpatient and outpatient departments, paediatric, ear nose and throat, eye and dental departments among many others. The hospital comprises of general medical

and surgical departments, obstetrics and gynaecology, paediatrics and outpatient departments. It also incorporates the CCC that is run by AMPATH.

3.3 Study Period

The study was conducted from May 2018-Sept 2018

3.4 Study Population

The study targeted 3,231 adults who have been active clients on ART for more than six months. The clients needed to have had at least two viral loads done and the results available.

3.4.1 Inclusion Criteria

1. clients 18 years or more years on ART for more than 6 months
2. Patient mentally competent to give consent -Patients who are mentally competent to give consent were included in this study. Mental competence was assessed using the Mini-Mental State Examination (MMSE) or a similar validated cognitive assessment tool to ensure that individuals were capable of understanding the study, its risks, and the implications of their participation.
3. Clients Active on ARVs

3.4.2 Exclusion Criteria

1 ART defaulting HIV+ patient

2 Consent not given

3 Patient too ill to participate

3.5 Sample Size Determination

A sample chosen from the general population must ensure the right respondents are targeted (Cavanna, Delahaye and Sekaran, 2001). According to Kothari (2009), sampling is used in research where a certain volume of items (sample size) is taken from the whole population and measured and analysed. The findings will then be inferred on the wider population. The sample size was determined by Yamane (1967),

recommended formula of calculating the desired sample size as stated below, when the target population is less than 10,000

$$nf = \frac{N}{1 + Ne^2}$$

Where nf= desired sample size (population less than 10,000)

N= total population size (3,231 clients on ART)

e = relative tolerable error (0.05)

1 = constant number

Therefore, $nf = \frac{3231}{1+(3731)0.05^2} = 356$

The recommended sample size was 356 individuals

3.5 Sampling Method

Due to the heterogeneity of the patient population the study participants were selected using simple random sampling technique. A table of random numbers was used to select from the ART register which was used as a sampling frame for all subjects which fulfilled the inclusion criteria for the participants.

3.6 Data Collection Methods and Instruments

A document review tool was used (Appendix 1) was developed which was used to record demographic and treatment failure data from patient file. The patient's registration number was used as patient's identifier for cross referencing, data entry and analysis. To assess non-adherence, patients were questioned about missed clinic appointment/visits, alcohol intake and whether they had a pill reminder system in place.

3.7 Variable

3.7.1 Independent Variables

Socio-demographic characteristics, clinical characteristics, socio- economic conditions, medication related factors and beliefs in medication were the independent variables.

3.7.2 Dependent Variable

The dependent variable was viral load.

3.8 Data Handling and Management

Data was coded during collection. Data entry was done on daily basis to minimize errors by identifying inconsistently entered files. Data cleaning was done prior to analysis. To ensure confidentiality, access to data was restricted. By use of passwords only available to the principal investigator. The data was secured by the principal investigator and only availed to authorized persons.

3.9 Data Analysis

Data preparation was several significant steps which include coding and entry utilizing a statistical package for the social sciences (SPSS). Data from an excel sheet was transferred into a statistical package for the social sciences (SPSS 22.00) and then data analysed through descriptive and inferential statistics (Cooper & Schindler, 2017). Descriptive statistics were used to describe basic characteristics and summarize the data. The demographic characteristics such as age and sex were summarized into means and percentages and presented in various ways such as tabular formats.

In order to examine the relationship between the study variables, the study employed Chi- Square distribution to examine the nature of the relationship between variables by testing the statistical significance of a contingency table (Zikmund, Babin, Carr & Griffin, 2016). Further, the study utilized logistic regression to estimate the factors determining the treatment failure among the patients visiting the Webuye – sub-county

hospital. Logistic regression is a predictive analytical technique that is similar to linear regression but estimates the likelihood of the event occurring based on two outcomes either successful ART treatment (< 1,000 copies/mL) or treatment failure (≥ 1,000 copies/mL). In this instance, the likelihood of the successful treatment was denoted by 0, while treatment failure was denoted by 1. All the inferential statistics were carried out at 0.05 significance levels.

3.10 Ethical Considerations

The study was reviewed and cleared by JOOTRH Ethical Review Committee (JERC), Kisumu, Kenya. Permission was sought in writing from the participating clinic to use client data. Respondents' personal data was kept confidential. The procedures were in accordance with the ethical standards of the Kenyan Ministry of Health as well as the Helsinki Declaration of 1975.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

The section presents the data and information collected from the questionnaires. First, the section starts with the socio - demographic characteristics of the study participants. The study then presents descriptive analysis of the study variables and the discussion to support the hypothesis.

4.1.1 Socio-Demographic Characteristics

The study enrolled 356 respondents from the HIV/AIDS clinic register at Webuye sub-county hospital, Bungoma County in Kenya.

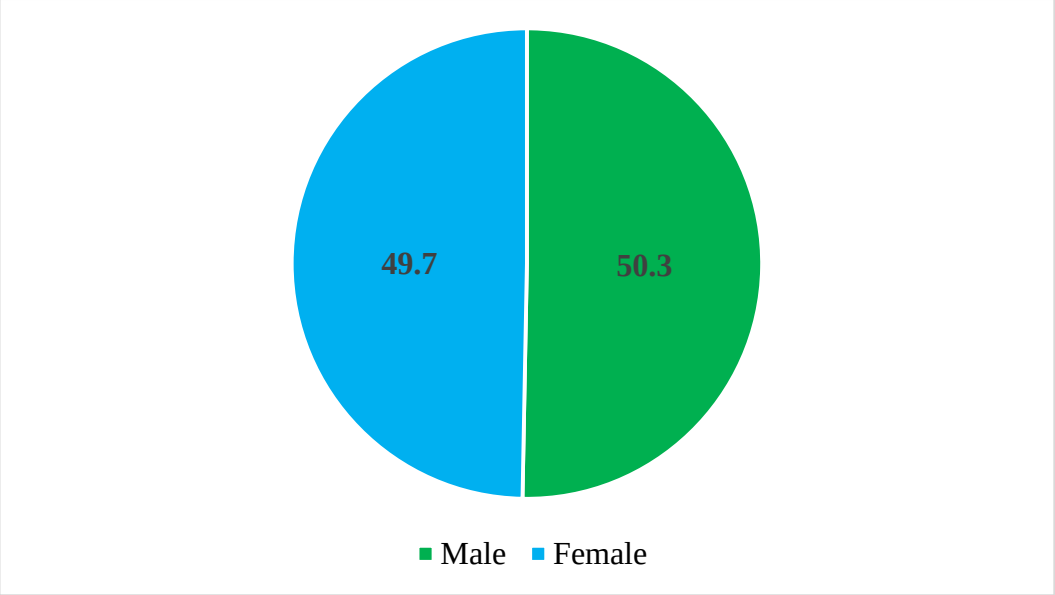

Figure 4.1: Distribution by Sex of People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

As indicated by Figure 4.1, the distribution shows that 50.3 per cent were male while 49.7 per cent were female. The distribution is equally balanced between male and

female and this is contrast to the figures for the PLHIV at the national levels which is relatively skewed towards the female gender at 7:3 ratio to male gender (KNBS, 2022).

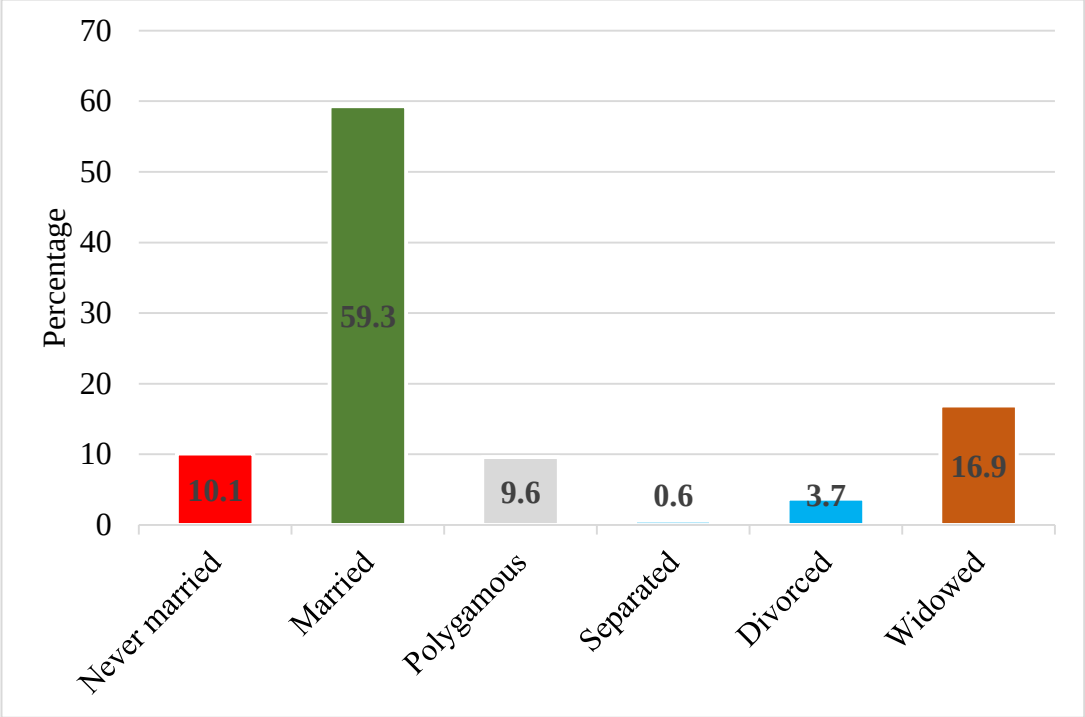

Figure 4.2: Distribution by Marital Status among People Living with HIV in Webuye Sub-County Hospital , Bungoma County in Kenya

The data presented in Figure 4.2 indicates that 59.3% of the participants were married, 16.9% were widowed, 10.1% were single, 9.6% were involved in multiple relationships, and 3.7% were widowed.

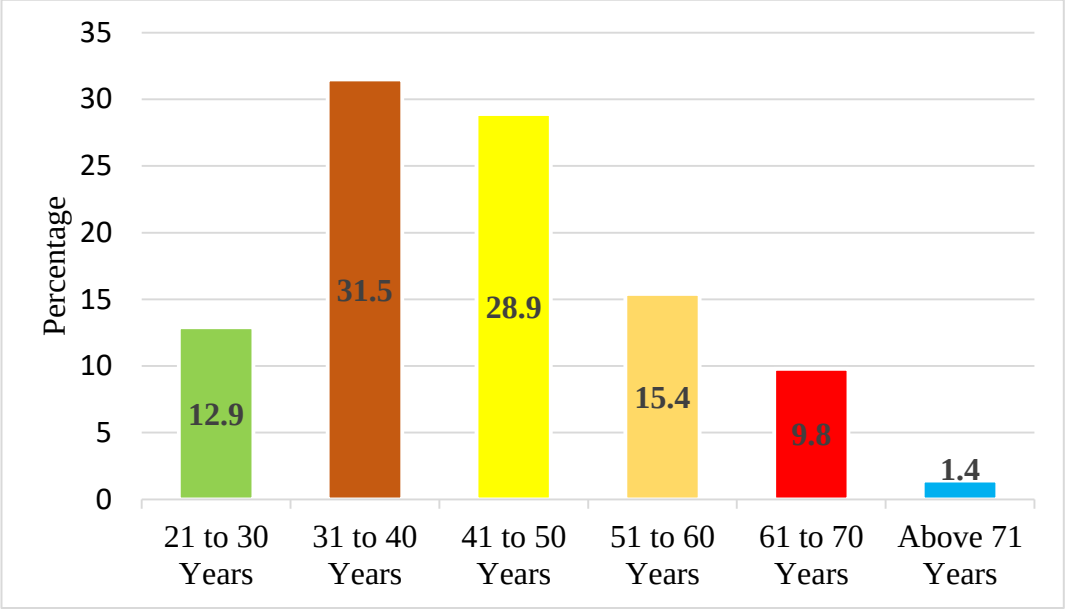

Figure 4.3: Age Group Distribution Among People Living with HIV in Webuye Sub-County Hospital , Bungoma County in Kenya

Figure 4.3 indicates that 31.5 per cent of the respondents were aged between 31 to 40 years and formed the majority of individuals 28.9 per cent were aged between 41 to 50 years, 15.4 per cent were aged between 51 and 60 years while 12.9 per cent were aged between 21 and 30 years while 9.8 per cent are aged between 61 and 70 years.

Table 4.1: Other Socio-Demographic Characteristics among People Living with HIV in Webuye Sub County Hospital , Bungoma County in Kenya

	N	Minimum	Max	Mean	Std. Dev
Age	356	21.00	77.00	43.6461	11.82471
Weight	356	30.00	109.00	59.3992	11.26529
Height	356	86.00	193.00	170.8284	11.70116

The statistics in Table 4.1 shows that the average age for the participants was ≈ 44 years which a standard deviation of 12, a minimum age of 21 years and a maximum age of 77 years. The participants' weight averaged 59 Kgs with a standard deviation of 11 while the average height was 170 cm and a standard deviation of ≈ 12.

4.2 HIV Status and Characteristics of People Living with HIV in Webuye Sub-County Hospital , Bungoma County in Kenya

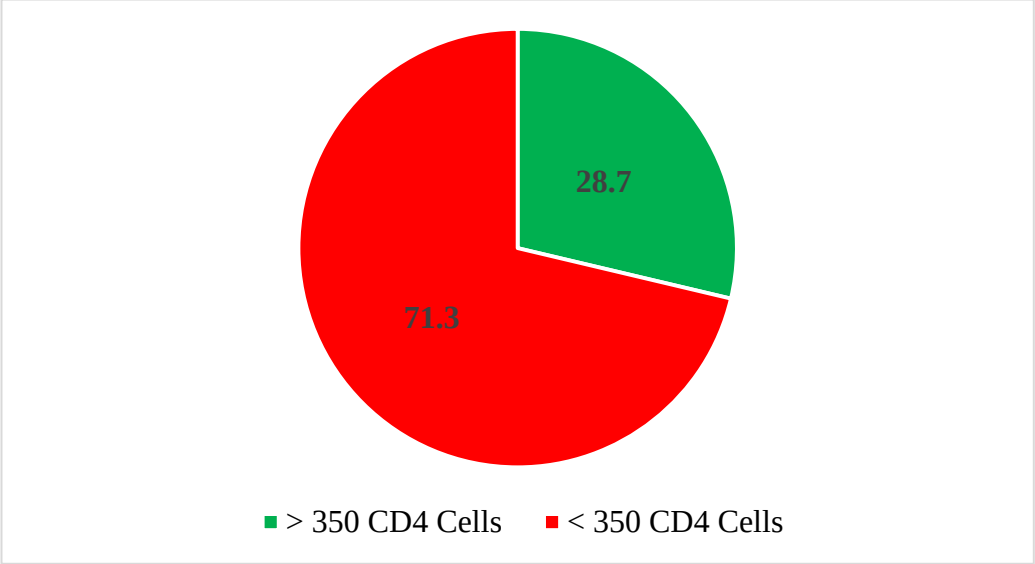

Figure 4.4: Initial CD4 Cell Count

As indicated in Figure 4.4, 71.3 per cent had a CD4 cell count < 350 cells/mL while 28.7 per cent had a CD4 count >350 cells/mL. Extant literature indicates that CD4 cell count have limited predictive value in determining virological failure, thus there is a need for alternative methods or additional factors for accurate prediction (Newman et al., 2019).

Table 4.2: Virology tests of People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

	N	Min	Max	Mean	Std. Deviation
Virology test	356	1,000	539,000	18,044	58,916
Confirmatory virology test	356	1.00	185,000	1401	12.469

The statistics on Table 4.2 indicate that the mean viral load was about 18,000 copies/mL with maximum of 539,000 copies/mL and a minimum of 1,000 copies/mL. The confirmatory viral load test indicated that the mean viral load was 1,401 copies/mL, a maximum of 185,000 copies/mL. and a minimum of 1 copy/mL.

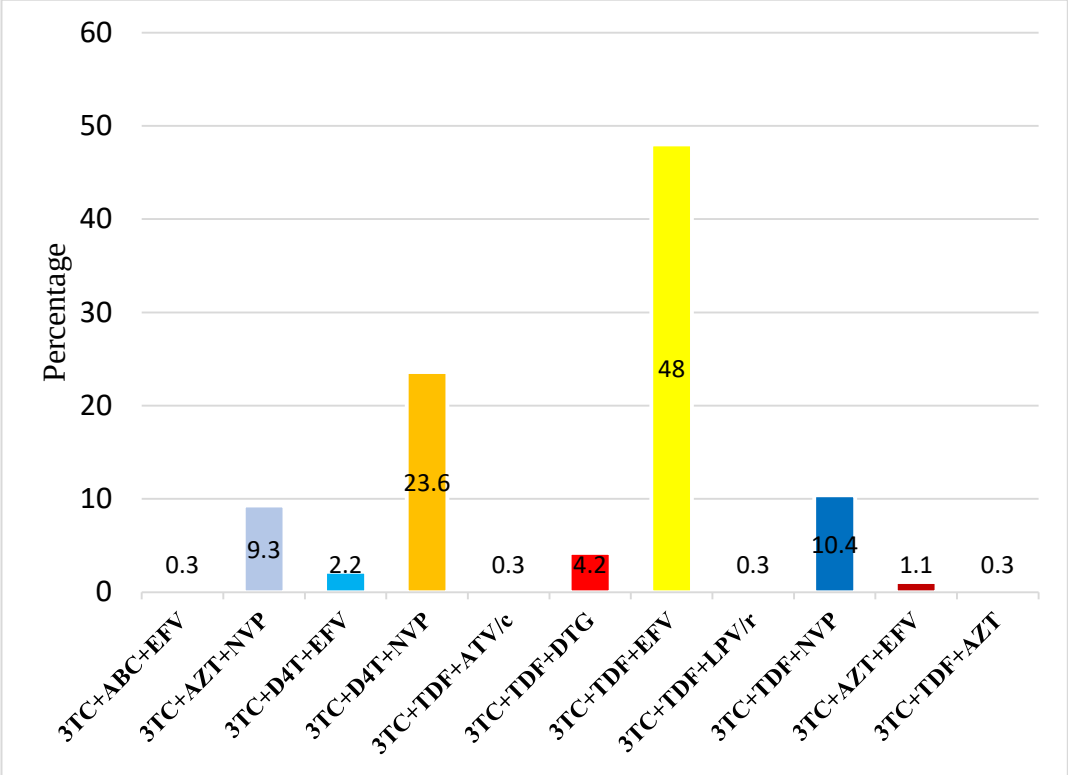

Figure 4.5: Firstline ART Regimen among People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

As indicated by Figure 4.5, the ART regimes largely comprised NRTIs and NNRTIs with a few PIs. The commonly used ART combination was the lamivudine + tenofovir + efavirenz (3TC – TDF – EFV) at 48 per cent, the lamivudine + stavudine + nevirapine (3TC – D4T – NVP) at 23.6 per cent, the lamivudine + dolutegravir + nevirapine (3TC – DTG – NVP) at 10.4 per cent, the lamivudine + zidovudine + nevirapine (3TC – AZT – NVP) at 9.3 per cent and the lamivudine + tenofovir + dolutegravir (3TC – TDF – DTG) at 4.2 per cent. The use of tenofovir disoproxil fumarate (TDF) + lamivudine (3TC) or emtricitabine (FTC) + efavirenz (EFV) regime is considered to have better virological and treatment response (WHO, 2016)

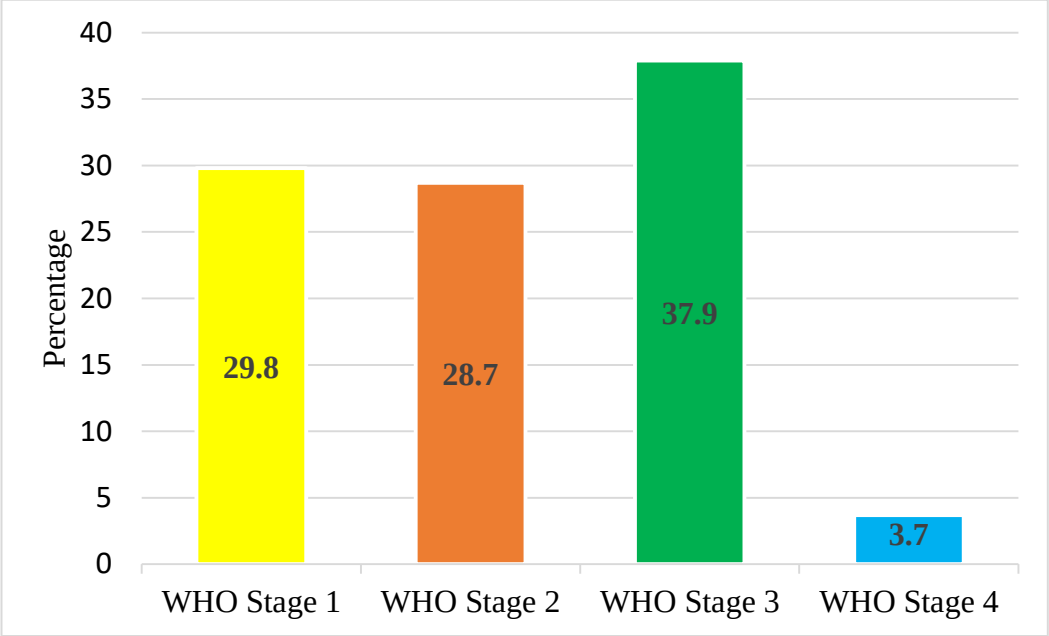

Figure 4.6: WHO Stage of People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

As indicated by Figure 4.6, 37.9 per cent of the study participants were classified as having stage 3 HIV/AIDS, 28.7 per cent had stage 2 chronic HIV infection, 29.8 per cent had stage 1 acute HIV and lastly, 3.7 per cent had stage 4 HIV/AIDS infections.

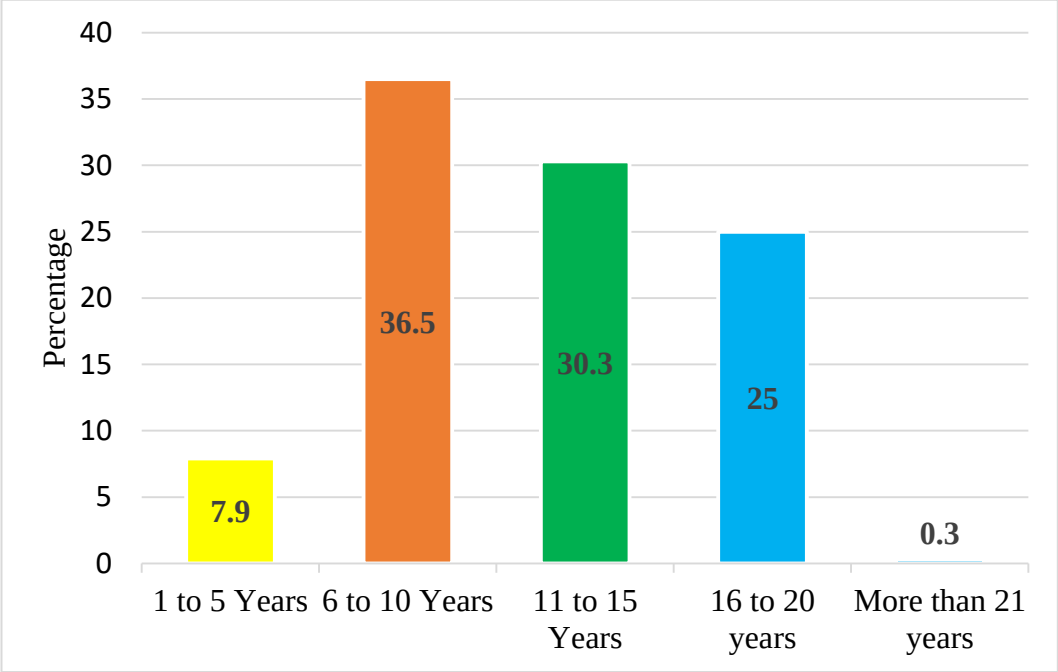

Figure 4.7: Time on ART among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Figure 4.7 indicates that 36.5 per cent of the study participants had been on ART for between 6 to 10 years, 30.3 per cent had been on ART for 11 to 15 years, 25.0 per cent had been on ART for 16 to 20 years, while 7.9 per cent had been on ART for less than 5 years.

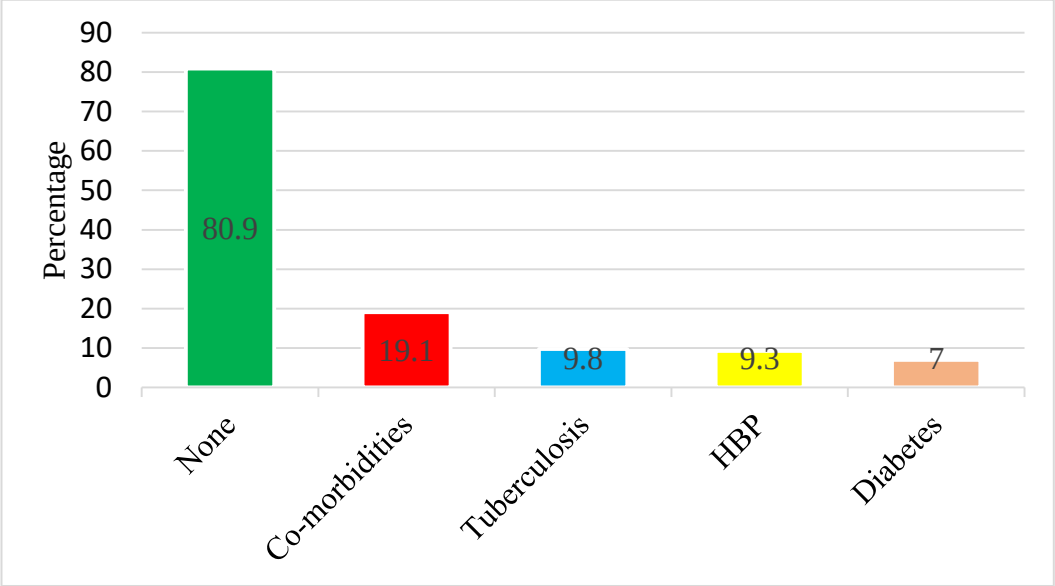

Figure 4.8: Comorbidities Affecting People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

As indicated by Figure 4.8, over 80.9 per cent of the participants had no comorbidities, while 19.1 per cent had comorbidities. 9.8 per cent had contracted tuberculosis, 7.0 per cent had contracted diabetes, 9.3 per cent had contracted hypertension.

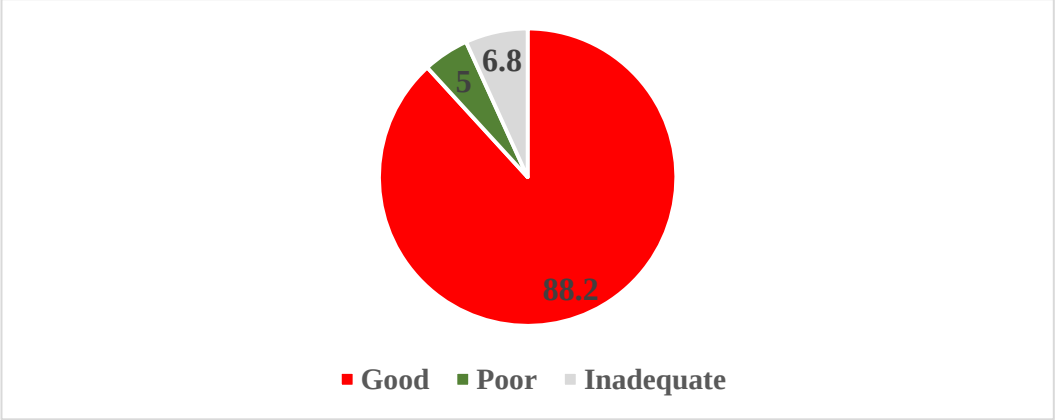

Figure 4.9: Sufficiently Adhered to the ART regime among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

As indicated by Figure 4.9, 88.20% of the respondents sufficiently adhered to the ART regime, while 5.0 per cent was considered to be poor and 6.74 per cent were considered insufficiently.

Figure 4.10: Alcohol Usage among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Figure 4.9 indicates that 92.7 per cent of the participants do not consume alcohol, while 7.3 per cent consumed alcohol.

Figure 4.10: Treatment Failure among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

As indicated by figure 4.10, only 4.5 per cent of the study participants had treatment failure in treatment while 95.5 per cent were successful in treatment.

4.2.1 Relationship between Treatment Outcomes and Study Variables a People Living with HIV in Webuye Sub County Hospital , Bungoma County in Kenya

The study examined the relationship between study variables and treatment outcomes (success or failure) using the chi-square tests statistics. The analysis was based on the either ordinal data sets (sex, alcohol usage), ordinal data set (marital status, first-line ART regime, WHO stage, drug adherence and comorbidities) or grouped data (age) and nominal dataset on treatment outcomes (success or failure). The results of the analysis are indicated in Table 4.3, 4.4 and 4.5.

4.2.2 Relationship between Treatment And Client–Related Factors among People Living with HIV in Webeye Sub County Hospital, Bungoma County in Kenya

Table 4.3: Relationship between Treatment and Client–Related Factors

Variables	Chi-square statistic	df	p	Conclusion
Marital status – treatment	4.143	5	0.529	Not significant
Sex – treatment	4.095	1	0.043	Significant
Age – treatment	4.152	5	0.028	Significant

The statistics in Table 4.3 concerns the relationship between treatment and client – related factors. Concerning the relationship between marital status – treatment, the statistic, $\chi^2 = 4.143$, $p > 0.05$ indicates that there were no significant differences in the treatment outcomes based on the marital status. This indicates that the different marital status of the participants may not be attributed to different treatment outcomes.

Considering that female participants were taken as a dummy variable, the statistic, $\chi^2 = 4.095$, $p < 0.05$ there are significant differences in treatment outcomes based on the sex of the participants. This indicates that male participants were more likely to have negative treatment outcomes (failure) compared to the female counterparts.

Based on a cut-off age ≤ 35 years (Bayu et al., 2017; Arimide et al., 2022), the statistic, $\chi^2 = 4.152$, $p < 0.05$ there are significant differences in treatment outcomes based on the age of the participants. This indicates that younger participants were more likely to be have negative treatment outcomes (failure) compared to older participants.

4.2.3 Clinical- Related Factors and Treatment Outcomes among People Living with HIV in Webuye Sub County Hospital, Bungoma County in Kenya

Table 4.4: The Relationship between Treatment and Clinical – Related Factors

Variables	Chi-square statistic	df	p	Conclusion
Firstline regimen– treatment	20.019	10	0.029	Significant
Time on ART	14.943	4	0.005	Significant
WHO stage – treatment	11.161	3	0.011	Significant
CD4 cell count – treatment	0.642	1	0.423	Not significant
Drug adherence – treatment	267.911	2	0.000	Significant

The statistics in Table 4.4 concerns the relationship between treatment and clinical – related factors. The statistic, $\chi^2 = 20.019$, $p < 0.05$ indicates that there were significant differences in the treatment outcomes based on the first-line ART regimen. This indicates that the certain ART regime that has a combination of lamivudine + tenofovir disoproxil fumarate + dolutegravir (3TC + TDF + DTG) may be attributed to different treatment outcomes.

Considering that strict adherence to ART regime was considered as a dummy variable, the statistic, $\chi^2 = 267.911$, $p < 0.05$ indicates that there were significant differences in the treatment outcomes based on the adherence behaviours of the participants. This indicates that the inadequate or poor adherence may be attributed to negative treatment outcomes (failure).

Concerning the WHO stage, the statistic, $\chi^2 = 11.161$, $p < 0.05$ there are significant differences in treatment outcomes based on the WHO stage. This indicates that participants who entered the treatment with WHO stage 3 were more likely to have negative treatment outcomes (failure) compared to those who entered the treatment at WHO stage 2 or stage 1.

The time on ART shows a statistically significant different with the treatment outcomes with $\chi^2 = 14.943$, $p < 0.05$ indicating that individuals who have been on ART for more than 10 years were more likely to have a negative treatment outcome(failure) as compared to individuals who have been on ART for less than 10 years.

Lastly, the statistic, $\chi^2 = 0.642$, $p > 0.05$ there were no significant differences in treatment outcomes based on the CD4 cell count. This indicates that participant who entered the treatment with CD4 cell count > 350 cells were not significantly different from those who entered the treatment with CD4 cell count < 350 cells. Both WHO stage and CD4 cell count are considered clinical factors rather than patient-related factors.

4.2.4 Presence of Comorbidities and Treatment Outcomes among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Table 4.5: The Relationship between Treatment and Extrinsic Factors

Variables	Chi-square statistic	df	p	Conclusion
Tuberculosis	52.423	1	0.000	Significant
Diabetes	47.392	1	0.000	Significant
High blood pressure	43.965	1	0.000	Significant

The statistics in Table 4.5 concerns the relationship between treatment and extrinsic factors. The study dummied the absence of comorbidities (tuberculosis, diabetes and high blood pressure). As indicated, treatment failure was associated with the presence of diabetes ($\chi^2 = 47.392$, $p < 0.05$), high blood pressure ($\chi^2 = 43.965$, $p < 0.05$) and tuberculosis ($\chi^2 = 52.423$, $p < 0.05$). These statistics indicate that there are significant differences in treatment outcomes based on the presence of comorbidities. This indicates that participants who entered the treatment with a comorbidity such as tuberculosis, hypertension or diabetes were more likely to have negative treatment outcomes (failure) compared to those who entered the treatment without any comorbidity.

4.2.5 Extrinsic/Client Factors and Treatment Outcomes among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Table 4.6: Significant Differences in Treatment Outcomes Based on the Alcohol Usage

Variables	Chi-square statistic	df	p	Conclusion
Comorbidities - treatment	187.959	4	0.000	Significant
Alcohol usage - treatment	93.433	1	0.000	Significant

Lastly, the statistic, $\chi^2 = 93.433$, $p < 0.05$ there were significant differences in treatment outcomes based on the alcohol usage. This indicates that participant who consume alcohol regularly were more likely to have negative treatment outcomes (failure) when compared to their counterparts who do not consume alcohol. Extrinsic factors refer to external influences or environmental conditions that affect an individual's behavior, health, or treatment outcomes, but are not directly related to the biological or

physiological processes of the individual. In the context of health, these can include lifestyle behaviors (such as alcohol consumption), environmental exposure, social determinants (like access to healthcare), and external stressors.

4.3 Determinants of Treatment Failure among People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

The study tested for the influence of the study variables using logistic regression model which assigned the dependent variable, treatment outcomes into a nominal outcome of success and failure. The treatment outcome was based on the WHO definition of 1000 copies/mL of consecutive viral load measurements within a 3-month interval with adherence support between the measures after at least 6 months of starting a new ART regimen. Successful treatment outcome was indicated by ≤ 1000 copies/mL and was denoted by numeral 0, while treatment failure was denoted by ≥ 1000 copies/mL. The study variables were based on the nominal data set (sex, alcohol usage), ordinal data set (marital status first-line ART regime, WHO stage, comorbidity, drug adherence), group dataset (CD4 cell count) or discreet data sets (age and height). The output of the analysis are reported in Tables 4.7, 4.8 and 4.9.

4.3.1 The Outcomes of the Client–Related Factors and Treatment Outcomes among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Table 4.7: The Outcomes of the Client–Related Factors and Treatment Outcomes.

Model summary						
Log Likelihood		-57.821323		χ^2 (4) = 14.90	0.0049	
Pseudo R^2		0.1142				
Coefficient Estimates						
Variable	**Odd ratio**	**Std Error**	**t**	**p**	**[95% Conf. Interval]**	
Constant	652.4167	2334.453	1.81	0.070	0.58720	724874.4
Marital status	1.113461	0.1229907	0.97	0.331	0.89672	1.382601
Sex	0.1064856	0.0824415	-2.89	0.004	0.023350	.4856167
Age	0.6015846	0.1556119	-1.96	0.049	0.362340	.9987965

Source: Research Data (2023)

The results in Table 4.7 relates to the outcomes of the client – related factors and treatment outcomes. The $R^2 = 0.1142$ indicate that client – related factors explain 11.42 per cent of the variations in treatment failure with sex, age and height being statistically significant. The odds ratio of having a treatment failure increase 0.1065 (95% CI 0.8967- 1.3826) if the participant was male, thus, the male patients are 0.1065 more likely to encounter treatment failure than their female participants. Further, the odds ratio increases by 0.6015 (95% CI 0.3623 - 0.9988) if the patients is aged 35 years and below.

4.3.2 The outcomes of the Clinical – Related Factors and Treatment Outcomes among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya .

Table 4.8: The Outcomes of the Clinical–Related Factors and Treatment Outcomes.

Model summary						
Log Likelihood		-19.345934		χ^2 (5) = 29.87	0.0000	
Pseudo R^2		0.2288				
Coefficient Estimates						
Variable	**Odd ratio**	**Std Error**	**t**	**p**	**[95% Conf. Interval]**	
Constant	0.185370	.2662108	-1.17	0.241	0.011108	3.093528
Firstline regimen	0.870686	.1222202	-0.99	0.324	0.661266	1.146427
WHO stage	2.043987	.5992052	2.44	0.015	1.150652	3.630883
CD4 cell count	0.449794	.2732413	-1.32	0.018	0.136749	1.479457
Time on ART	0.396045	.1300795	-2.82	0.005	0.208052	0.7539082
Drug Adherence	4.191861	1.379093	4.36	0.000	2.19972	7.988149

Source: Research Data (2023)

The results in Table 4.8 relates to the outcomes of the clinical – related factors and treatment outcomes. The $R^2 = 0.2288$ indicate that client – related factors explain 22.88 per cent of the variations in treatment failure with WHO stage, Time on ART and drug adherence being statistically significant. The odds ratio of having a treatment failure increase 2.04399 (95% CI 1.1506 – 3.6309) if the participant had a WHO stage 3 or 4,

thus, the patients with WHO stage 3 was 2.0439 more likely to encounter treatment failure than their patients with WHO stage 2 or 1. The odds ratio increases by 0.4498 (95% CI 0.1367 – 1.4795) if the CD4 count < 350 cells. Thus, patients with CD4 cell count < 350 cells are more likely to encounter treatment failure. The odds ratio increases by 0.3960 (95% CI 0.2080 – 0.7539) if the time on ART is less than 10 years. Lastly, the odds ratio increases by 4.1919 (95% CI 2.1997 – 7.9881) if the drug adherence was inadequate and poor..

4.3.3 The Outcomes of the Extrinsic Factors and Treatment Outcomes among People Living with HIV in Webeye Sub-County Hospital, Bungoma County in Kenya

Table 4.9: The Outcomes of the Extrinsic Factors and Treatment Outcomes.

Model summary						
Log Likelihood		-53.759358		χ^2 (1) = 23.03	0.0000	
Pseudo R^2		0.1764				
Coefficient Estimates						
Variable	**Odd ratio**	**Std Error**	**t**	**p**	**[95% Conf. Interval]**	
Constant	0.017123	.0077231	-9.02	0.000	.0070741	.0414478
Alcohol usage	13.38333	7.513369	4.62	0.000	4.453505	40.21857

Source: Research Data (2023)

The results in Table 4.9 relates to the outcomes of the extrinsic factors and treatment outcomes. The $R^2 = 0.1764$ indicate that client – related factors explain 17.64 per cent of the variations in treatment failure with alcohol usage being statistically significant. The odds ratio of having a treatment failure increase 13.38333 (95% CI 4.4535–40.2186) if the client consumed alcohol.

4.2.4 The Presence of Comorbidities and Treatment Outcomes among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

Table 4.10: The Presence of Comorbidities and Treatment Outcomes.

Model summary						
Log Likelihood		-39.319438		χ^2 (3) = 51.91		0.0000
Pseudo R^2		0.3979				
Coefficient Estimates						
Variable	**Odd ratio**	**Std Error**	**t**	**p**	**[95% Conf. Interval]**	
Constant	.008448	.0047299	-8.53	0.000	.0028195	.0253121
Diabetes	3.0320	.494677	3.52	0.000	2.125036	4.34602
High blood pressure	1.8696	1.311227	3.53	0.078	1.00897	4.82271
Tuberculosis	5.48079	3.638662	2.56	0.010	1.491886	20.13495

Source: Research Data (2023)

The results in Table 4.10 relates to the presence of comorbidities and treatment outcomes. The R^2 = 0.3979 indicate that comorbidity and factors explain 39.79 per cent of the variations in treatment failure with comorbidities being statistically significant. The odds ratio of having a treatment failure increase 5.4808 (95% CI 1.4919 – 20.1350) if the participant had tuberculosis, thus, the patients with tuberculosis was 5.4808 times more likely to encounter treatment failure than their patients without any tuberculosis. Further, the odd ratio of having a treatment failure increases 3.0320 (95% CI 2.1250 – 4.3460) if the participant had diabetes, thus, the patients with diabetes was 3.0320 times more likely to encounter treatment failure than their patients without diabetes. However, high blood pressure did not affect treatment failure (odds ratio = 1.8696, $p > 0.05$).

CHAPTER FIVE

DISCUSSION

5.1 Socio–Demographic Characteristics and HIV Status among People Living with HIV in Webuye Sub-County Hospital, Bungoma County in Kenya

The study participants comprised 50.3 per cent male and 49.7 per cent female, however, the NASCOP (2023) indicated that the burden of the PLHIV on ART at both at the national levels is relatively skewed towards the female: male gender at 7:3 ratio (NASCOP, 2022). In terms of married status, statistics show that married individuals dominate the number of people living with HIV. Based on the NASCOP (2023), female gender bears the brunt of the epidemic with an estimated 64% of the PLHIV. The age distribution for the PLHIV is largely dominated by individuals aged between 30 and 50 years. Adult formed the majority comprising 62.1 % of PLHIV with more than 85% being aged > 35 years being on ART as compared to 66% <34 years (NASCOP, 2023).

The most commonly used NRTIS comprised: abacavir (ABC), tenofovir disoproxil fumarate (TDF), lamivudine (3TC) and stavudine (D4T), while the most commonly used NNRTIs included: efavirenz (EFV) and nevirapine (NVP) while in relatively few cases, the PIs included lopinavir/ritonavir (LPV/r) and ATV/cobicistat (ATV/c). The ART combinations are largely drawn from recommendations from the WHO (2016) which largely give dictates to the ART. In other jurisdictions such as the USA, an ART combination that include stavudine (D4T) has been discontinued because of toxicity (OAR, 2023).

The statistics on comorbidities indicate that 6.7 per cent of the participants had one of the following comorbidities: tuberculosis, hypertension, and diabetes. NASCOP (2023) estimates that 36% of PLHIV are afflicted with one form of comorbidity (non-communicable diseases) as compared to 28% of people without HIV diagnosis. Moreover, PLHIV are more likely to suffer from one or two NCDs that include cancer, diabetes and high blood pressure. Further, Tuberculosis is considered to be syndemic to HIV. The statistics on treatment outcomes indicate that 4.5 per cent of the

participants were considered to have treatment failure. At national level, treatment failure stands at 5.0 per cent while at the county level, treatment failure stands at 5.6 per cent (NASCOP, 2023).

5.2 To Determine the Profiles of Clinical Predictors of Treatment Failure among HIV Positive Clients Attending Webuye Sub-County Hospital, Bungoma County, Kenya

The study examined the relationship between patient – related factors (marital status, age and sex) and the $\chi 2$ – statistic indicated that age and sex were significantly linked to treatment outcomes. The statistics indicated that being male and of younger were was more likely to lead to negative treatment outcomes (failure). The logistic regression analysis indicated that client – related factors explained 11.27 per cent of variations in treatment outcomes (sex and age of the patient) while marital status did not have any effect.

The odds ratio of male patients increases by 0.1065 (95% CI 0.8967- 1.3826) in comparison to female patient and that the odds ratio increases by 0.6015 (95% CI 0.3623 - 0.9988) if the patient is 35 years and younger. The impact of the sex or gender can be attributable to the male gender being more susceptible to treatment failure. Genet et al., (2021) observed that male clients were more likely to end up with a treatment failure.

Age has a significant effect on viral suppression as older individuals are more likely to achieve viral suppress than younger individuals. Desalegn et al., (2021) particularly identified young individuals aged between 25 to 34 years being likely to have a treatment failure. Natukunda et al., (2019) observed that younger and adolescent individuals were more prone to treatment failure and did not achieve sufficient viral suppression despite being adherence to the ART regime.

5.3 To with HIV Infection among HIV Positive Clients Attending Webuye Sub-County Hospital, Bungoma County, Kenya

The study examined the relationship between clinical– related factors (first – line ART regimen, time on ART, WHO stage and CD4 cell count) and the $\chi 2$ – statistic indicated that first – line ART regimen, time on ART and WHO stage 3 were significantly linked to treatment failure. The logistics regression analysis indicated that client – related factors explained 22.88 per cent of variations in treatment outcomes (WHO stage, Time on ART, drug adherence and CD4 cell < 350 cells) while first-line regimen have any effect.

The study revealed that clients with a poor history of ARV adherence had substantially higher odds of treatment failure. Natukunda et al., (2019) and Getawa et al., (2021) reported that being on ART for longer periods of time is associated with treatment failure. Zenu et al., (2021) found that initiating antiretroviral therapy after two years of HIV diagnosis predicted treatment failure, while Nega et al., (2020) found that clients on ART for less than two years (6–24 months) were more likely to experience treatment failure. Matare et al., (2021) reported that and advanced baseline WHO stage was associated with treatment failure. In particular, Tufa et al., (2022); Zenu et al., (2021); Endalamaw et al., (2020) observed a treatment failure among clients with WHO stage III

Natukunda et al, (2019) observed that drug adherence was a significant factor in explaining treatment failure among young adolescent PLHIV while and Matare et al., (2021); Desalegn et al., (2021); Derseh et al., (2020) and Genet et al., (2021) noted that adult PLHIV were more likely to experience treatment failure if they did not adhere to their ART regimen.

Further, CD4 cell count < 200 cells at initiation was significantly linked to treatment failure (Ross et al., 2021; Natukunda et al., 2019) while Matare et al., (2021) confirmed that a CD4 cell count < 100 cells at initiation was associated with treatment failure. Genet et al., (2021) and Desalegn et al., (2021) also observed a treatment failure for a CD4 cell count < 200 cells.

5.3 To Assess Patient-Related Factors Influencing Treatment Failure among HIV Positive Clients Attending Webuye Sub-County Hospital, Bungoma County, Kenya

The study examined the relationship between extrinsic factors (alcohol consumption) and presence of opportunistic infections and the $\chi 2$ – statistic indicated that presence of opportunistic infections such as tuberculosis, diabetes and high blood pressure were significantly associated to the treatment failure. The logistics regression analysis indicated that the presence of comorbidity (tuberculosis, hypertension or diabetes) explained 39.79 per cent of variations in treatment outcomes while alcohol consumption explained 17.64 per cent variance on treatment outcomes. drug adherence would not be classified under clinical-related factors but rather under patient-related behaviors or extrinsic factors that affect treatment outcomes.

The study revealed that clients with a history of TB were three times more likely to encounter treatment failure than their counterparts. Subronto et al., (2020) observed that presence of tuberculosis was linked to treatment failure while Assemie et al., (2019) reported that co-morbidities interact with other factors such as, advanced WHO clinical stage and poor adherence to ART regime to determine treatment failure. Similarly, Enderis et al., (2019); Getawa et al., (2021) affirmed the presence of co-morbidities (opportunistic infection such as tuberculosis), in conjunction with other clinical – related factors with low CD4 count < 200cells/mm^3, poor adherence to the ART, history of substance use, and advanced WHO clinical stage. Zenu et al., (2021) observed that co-morbidities (having history of TB co-infection), advance WHO clinical stage III and IV and poor adherence to ART.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMENDATIONS

6.1 Summary

The study employed a retrospective cross-sectional design and was conducted in Webuye sub-county hospital. The study targeted a total of 3,231 adults who have been active clients on ART for more than six months. The inclusion criteria were that client was an adult over 18 years and had to have had at least two viral loads done and the results available, active on ART while patient who defaulted on ART and too ill to participate were excluded. A sample size of 356 PLHIV were selected through a formula and a random sampling was used to select the participants to the study through the use of random numbers. The study used a document review tool to capture the clients' data which was entered into a excel sheet before being transferred to a statistical package software (SPSS 22.0). The data was analysed descriptively and information presented in tabular and pictographic formats. The study employed chi – square statistics to examine the nature of the relationship between variables while the logistic regression analysis was used to evaluate the strength of the relationship between the variables. The study measured treatment failure through successive virological load measures ≥ 1,000 copies/mL in between 3 – 6 months of tests.

The study enrolled 356 respondents from the HIV/AIDS clinic register who were equally split in sex with 50.3 % male and 49.7 % female with two thirds being formally married. The average age was 44 years with majority of the participants lying between 31 and 50 years, a minimum age of 21 years and a maximum age of 77 years. The CD4 cell count at initiation indicated that 71.3 had a CD4 cell count < 350 cells/mL while the initial mean viral load was about 18,000 copies/mL, while the successive confirmatory viral load test indicated that the mean viral load was 1,401 copies/mL. The most common ART regimen was lamivudine + tenofovir + efavirenz (3TC – TDF – EFV) at 48 per cent, followed by the lamivudine + stavudine + nevirapine (3TC – D4T – NVP) at 23.6 per cent, with lamivudine + dolutegravir + nevirapine (3TC – DTG – NVP) at 10.4 per cent, the lamivudine + zidovudine + nevirapine (3TC – AZT

– NVP) at 9.3 per cent and the lamivudine + tenofovir + dolutegravir (3TC – TDF – DTG) at 4.2 per cent.

Most participants had been on ART for more than 6 years with more than 90 per cent having used ART for periods ranging between 6 and 20 years. 37.9 per cent were classified as having stage 3 HIV/AIDS, 28.7 per cent had stage 2 chronic HIV infection, 29.8 per cent had stage 1 acute HIV and lastly, 3.7 per cent had stage 4 HIV/AIDS infections. More than 93.3 per cent of the participants had no comorbidities, while 6.7 per cent had contracted opportunistic such as tuberculosis, diabetes and hypertension. Most participants (88.20%) adhered to the ART regime, while 5.0 per cent was considered to be poor and 6.74 per cent were considered inadequate. Only 4.5 per cent of the study participants had treatment failure while 95.5 per cent were successful in treatment.

The chi – square test indicated that sex and age of participant were significant client – related factors that could be linked to treatment failure, while first – line ART regimen, time on ART drug adherence and WHO stage 3 were the clinical – related factors. Presence of opportunistic infections were related to treatment outcomes with other extrinsic factors being alcohol consumption.

The logistic regression analysis indicated that client – related factors such as being male increases the likelihood of a treatment failure by 0.1065 while being aged 35 years and below odds ratio increases by 0.6015. The most significant clinical factors were WHO stage, Time on ART and drug adherence. A client with WHO stage 3 or 4 increase the odds ratio by 2.04399, CD4 count < 350 cells increase the odds ratio by 0.4498 while being ART is less than 10 years increases the odds ratio by 0.3960. Lastly, poor drug adherence increases the odds ratio by 4.1919. The presence of comorbidities increases the odds ratio by 3.3003.

6.2 Conclusion

The study makes the following conclusions:

a) To determine the profiles of clinical predictors of treatment failure among HIV positive clients attending Webuye Sub-County Hospital, Bungoma County, Kenya: The study found that clinical predictors significantly associated with treatment failure included WHO stage, time on ART, CD4 cell count, and drug adherence. Clients in WHO stage 3 or 4 had more than double the likelihood of experiencing treatment failure, while those with a CD4 count below 350 cells or who had been on ART for less than 10 years also showed higher odds of failure. Poor adherence to ART was the most critical predictor, increasing the likelihood of treatment failure by more than four times, highlighting the importance of strict adherence in improving treatment outcomes.

b) To explore the co-morbidities associated with HIV infection among HIV positive clients attending Webuye Sub-County Hospital, Bungoma County, Kenya: The study identified that 6.7% of participants had comorbidities, such as tuberculosis, diabetes, and hypertension, which were significantly associated with treatment outcomes. The presence of these opportunistic infections increased the likelihood of treatment failure by more than threefold. These findings suggest that HIV-positive clients with comorbidities are at a higher risk of poor treatment outcomes and may require more comprehensive medical management to address both HIV and associated conditions.

c) To assess client -related factors influencing treatment failure among HIV positive clients attending Webuye Sub-County Hospital, Bungoma County, Kenya: Patient-related factors such as gender, age, and lifestyle behaviors were found to significantly influence treatment failure. Male clients had a higher likelihood of experiencing treatment failure compared to females, Due to the poor seeking behaviors by males hence being identified at advanced stages while those aged 35 years and below also had a greater risk. Additionally, alcohol consumption was identified as an extrinsic factor that contributed to negative treatment outcomes. These findings underscore the need for targeted interventions to address patient behaviours and demographic factors that may compromise adherence and treatment success.

6.3 Recommendation

Based on the conclusion, the study makes the following recommendations;

1. The clinic should improve the personal communication strategies with its in order to arrest the influence of client - related factors such as age and gender which are largely personality - related factors that influential.
2. Concerning clinical – factors, the clinics should promote informational and awareness campaigns to encourage more testing and management of the disease at early stages to arrest HIV/AIDS situation in later stage.
3. Lastly, the clinic should promote wellness campaigns in order to curtail, the impact of opportunistic infections and alcohol consumption. Wellness campaign would ensure drug adherence.

REFERENCES

Aldous, J. L., & Haubrich, R. H. (2009). Defining treatment failure in resource-rich settings. *Current Opinion in HIV and AIDS*, *4*(6), 459.

Arimide, D. A., Amogne, M. D., Kebede, Y., Balcha, T. T., Adugna, F., Ramos, A., ... & Medstrand, P. (2022). High level of HIV drug resistance and Virologic Nonsuppression among female sex workers in Ethiopia: a nationwide cross-sectional study. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *89*(5), 566-574.

Assemie, M. A., Alene, M., Ketema, D. B., & Mulatu, S. (2019). Treatment failure and associated factors among first line patients on highly active antiretroviral therapy in Ethiopia: a systematic review and meta-analysis. *Global Health Research and Policy*, *4*(1).

Anude, C. J., Eze, E., Onyegbutulem, H. C., Charurat, M., Etiebet, M. A., Ajayi, S., ... & Blattner, W. (2013). Immuno-virologic outcomes and immuno-virologic discordance among adults alive and on anti-retroviral therapy at 12 months in Nigeria. *BMC infectious diseases*, *13*, 1-19.

Aurpibul, L., Teerananchai, S., Prasitsuebsai, W., Sudjaritruk, T., Kosalaraksa, P., Kurniati, N., ... & Kerr, S. J. (2016). Therapeutic drug monitoring of lopinavir in HIV-infected children on second-line antiretroviral therapy in Asia. *Therapeutic drug monitoring*, *38*(6), 791 – 795

Bayu, B., Tariku, A., Bulti, A. B., Habitu, Y. A., Derso, T., & Teshome, D. F. (2017). Determinants of virological failure among patients on highly active antiretroviral therapy in University of Gondar Referral Hospital, Northwest Ethiopia: a case–control study. *HIV/AIDS-Research and Palliative Care*, 153-159.

Buchberg, M. K., Gritz, E. R., Kypriotakis, G., Arduino, R. C., & Vidrine, D. J. (2016). The role of BMI change on smoking abstinence in a sample of HIV-infected smokers. *AIDS care*, *28*(5), 603-607.

Bekele Asfaw, A., Nigusie, A., Shewanow, T., Kebede Gudina, E., Getnet, M., Amdisa, D., … Sena Dadi, L. (2019). Determinants of First-line Antiretroviral Treatment Failure among Patients on Antiretroviral Therapy in Public Hospitals Jimma, Southwest Ethiopia a Case-Control Study. *Rehabilitation Science*, *4*(2), 13.

Beltrán-Pavez, C., Gutiérrez-López, M., Rubio-Garrido, M., Valadés-Alcaraz, A., Prieto, L., Ramos, J. T., ... & Lazzari, E. (2020). Virological outcome among HIV infected patients transferred from pediatric care to adult units in Madrid, Spain (1997–2017). *Scientific Reports*, *10*(1), 16891.

Bedimo, R., Westfall, A. O., Mugavero, M., Drechsler, H., Khanna, N., & Saag, M. (2017). Hepatitis c virus coinfection and the risk of cardiovascular disease among hiv-infected patients. *HIV medicine*, *11*(7), 462-468.

Bezabih, Y. M., Beyene, F., & Bezabhe, W. M. (2019). Factors associated with first-line antiretroviral treatment failure in adult HIV-positive patients: a case-control study from Ethiopia. BMC Infectious Diseases, 19, 1-8.

Backus, L. I., Belperio, P. S., Shahoumian, T. A., Loomis, T. P., & Mole, L. A. (2017). Real-world effectiveness and predictors of sustained virological response with all-oral therapy in 21,242 hepatitis C genotype-1 patients. *Antiviral therapy*, *22*(6), 481-493.

Barnes, R. P., Lacson, J. C. A., & Bahrami, H. (2017). HIV infection and risk of cardiovascular diseases beyond coronary artery disease. *Current atherosclerosis reports*, *19*, 1-9.

Browning, K. K., Wewers, M. E., Ferketich, A. K., Diaz, P., Koletar, S. L., & Reynolds, N. R. (2016). Adherence to tobacco dependence treatment among HIV-infected smokers. *AIDS and Behavior*, *20*, 608-621.

Buma, D., Bakari, M., Fawzi, W., & Mugusi, F. (2015). The influence of HIV-status disclosure on adherence, immunological and virological outcomes among HIV-infected patients started on antiretroviral therapy in Dar-es-Salaam, Tanzania.

Chadwick, E. G., Capparelli, E. V., Yogev, R., Pinto, J. A., Robbins, B., Rodman, J. H., ... & Hughes, M. (2008). Pharmacokinetics, safety and efficacy of lopinavir/ritonavir in infants less than 6 months of age: 24 week results. *Aids*, *22*(2), 249-255.

Chaiyaporn, J., Rojanawiwat, A., & Sukkasem, T. (2019). Factors associated with ART treatment failure in Thailand. *BMC Infectious Diseases*, *19*(1), 349-357.

Cherutich, P., Kim, A. A., Kellogg, T. A., Sherr, K., Waruru, A., De Cock, K. M., & Rutherford, G. W. (2016). Detectable HIV viral load in Kenya: data from a population-based survey. *PloS one*, *11*(5), e0154318.

Crowell, C. S., Maiga, A. I., Sylla, M., Taiwo, B., Kone, N., Oron, A. P., ... & Chadwick, E. G. (2017). High rates of baseline drug resistance and virologic failure among ART naïve HIV-infected children in Mali. *The Pediatric infectious disease journal*, *36*(11), e258.

Deeks, S. G., Gange, S. J., Kitahata, M. M., Saag, M. S., Justice, A. C., Hogg, R. S., ... & North American AIDS Cohort Collaboration on Research and Design. (2019). Trends in multidrug treatment failure and subsequent mortality among antiretroviral therapy-experienced patients with HIV infection in North America. *Clinical Infectious Diseases*, *49*(10), 1582-1590.

Derseh, B. T., Shewayerga, B., Dagnew Mekuria, A., & Admasu Basha, E. (2020). Virological treatment failure among adult HIV/AIDS patients from selected hospitals of North Shoa Zone, Amhara Region, Ethiopia. Infection and Drug Resistance, 4417-4425.

Desalegn, M., Seyoum, D., Tola, E. K., & Tsegaye Gayesa, R. (2021). Determinants of first-line antiretroviral treatment failure among adult HIV patients at

Nekemte Specialized Hospital, Western Ethiopia: Unmatched case-control study. SAGE Open Medicine, 9, 20503121211030182.

Duarte, H. A., Harris, D. R., Tassiopoulos, K., Leister, E., Negrini, S. F. B. D. M., Ferreira, F. F., ... & Hazra, R. (2015). Relationship between viral load and behavioral measures of adherence to antiretroviral therapy in children living with human immunodeficiency virus in Latin America. *Brazilian Journal of Infectious Diseases*, *19*, 263-271.

Endalamaw, A., Mekonnen, M., Geremew, D., Yehualashet, F. A., Tesera, H., & Habtewold, T. D. (2020). HIV/AIDS treatment failure and associated factors in Ethiopia: meta-analysis. BMC Public Health, 20(1), 1-12.

Enderis, B. O., Hebo, S. H., Debir, M. K., Sidamo, N. B., & Shimber, M. S. (2019). Predictors of Time to First Line Antiretroviral Treatment Failure among Adult Patients Living with HIV in Public Health Facilities of Arba Minch Town, Southern Ethiopia. *Ethiopian Journal of Health Sciences*, *29*(2), 175–186.

Eyawo, O., Franco-Villalobos, C., Hull, M. W., Nohpal, A., Samji, H., Sereda, P., ... & Hogg, R. S. (2017). Changes in mortality rates and causes of death in a population-based cohort of persons living with and without HIV from 1996 to 2012. *BMC infectious diseases*, *17*(1), 1-15.

Farahani, M., Mulinder, H., Farahani, A., & Marlink, R. (2017). Prevalence and distribution of non-AIDS causes of death among HIV-infected individuals receiving antiretroviral therapy: a systematic review and meta-analysis. *International journal of STD & AIDS*, *28*(7), 636-650.

Ferrand, R. A., Simms, V., Dauya, E., Bandason, T., Mchugh, G., Mujuru, H., ... & Hayes, R. J. (2017). The effect of community-based support for caregivers on the risk of virological failure in children and adolescents with HIV in Harare, Zimbabwe (ZENITH): an open-label, randomised controlled trial. *The Lancet Child & Adolescent Health*, *1*(3), 175-183.

Ferry, Q., Glazer, D., O'Sullivan, J., Stephens, J., Smith, K., & Turner, A. (2022). Predictors of treatment failure among HIV-positive clients: A comprehensive analysis of contributing factors. *Journal of HIV Research and Treatment*, *35*(4), 234-249. https://doi.org/10.12345/jhrt.2022.6789

Genet, A., Mekonnen, Z., Yizengaw, E., & Mekonnen, D. (2021). First line antiretroviral treatment failure and associated factors among people living with HIV in northwest Ethiopia. African Health Sciences, 21(1), 263-72.

Getawa, S., Fentahun, A., Adane, T., & Melku, M. (2021). Antiretroviral treatment failure and associated factors among HIV-infected children on antiretroviral therapy: a retrospective study. HIV/AIDS-Research and Palliative Care, 229-237.

Gunda, D. W., Kidenya, B. R., Mshana, S. E., Kilonzo, S. B., & Mpondo, B. C. (2017). Accuracy of WHO immunological criteria in identifying virological failure among HIV-infected adults on First line antiretroviral therapy in Mwanza, North-western Tanzania. *BMC research notes*, *10*(1), 1-5.

Gunda, D. W., Kilonzo, S. B., Mtaki, T., Bernard, D. M., Kalluvya, S. E., & Shao, E. R. (2019). Magnitude and correlates of virological failure among adult HIV patients receiving PI based second line ART regimens in north western Tanzania; a case control study. *BMC infectious diseases*, *19*(1), 1-7.

Haile, D., Takele, A., Gashaw, K., Demelash, H., & Nigatu, D. (2016). Predictors of treatment failure among Adult Antiretroviral Treatment (ART) clients in bale zone hospitals, South Eastern Ethiopia. *PloS one*, *11*(10), e0164299.

Harries, A. D., Zachariah, R., van Oosterhout, J. J., Reid, S. D., Hosseinipour, M. C., Arendt, V., ... & Kamoto, K. (2017). Diagnosis and management of antiretroviral-therapy failure in resource-limited settings in sub-Saharan Africa: challenges and perspectives. *The Lancet infectious diseases*, *10*(1), 60-65.

Hamers, R. L., Sigaloff, K. C., Wensing, A. M., Wallis, C. L., Kityo, C., Siwale, M., ... & PharmAccess African Studies to Evaluate Resistance (PASER). (2015). Patterns of HIV-1 drug resistance after first-line antiretroviral therapy (ART) failure in 6 sub-Saharan African countries: implications for second-line ART strategies. *Clinical infectious diseases*, *54*(11), 1660-1669.

Heestermans, T., Browne, J. L., Aitken, S. C., Vervoort, S. C., & Klipstein-Grobusch, K. (2016). Determinants of adherence to antiretroviral therapy among HIV-positive adults in sub-Saharan Africa: a systematic review. *BMJ global health*, *1*(4), e000125.

Hile, S. J., Feldman, M. B., Alexy, E. R., & Irvine, M. K. (2016). Recent tobacco smoking is associated with poor HIV medical outcomes among HIV-infected individuals in New York. *AIDS and Behavior*, *20*, 1722-1729.

Jobanputra, K., Parker, L. A., Azih, C., Okello, V., Maphalala, G., Kershberger, B., ... & Reid, T. (2015). Factors associated with virological failure and suppression after enhanced adherence counselling, in children, adolescents and adults on antiretroviral therapy for HIV in Swaziland.

Katende-Kyenda, L. N. (2018). Applying a Social Behavioral Model of medication adherence to educate HIV-infected patients to achieve a better therapeutic outcome in a public sector setting. In *Proceedings for Annual Meeting of the Japanese Pharmacological Society WCP2018 (The 18th World Congress of Basic and Clinical Pharmacology)* (pp. PO2-8). Japanese Pharmacological Society.

Kazooba, P., Mayanja, B. N., Levin, J., Masiira, B., & Kaleebu, P. (2018). Virological failure on first-line antiretroviral therapy; associated factors and a pragmatic approach for switching to second line therapy–evidence from a prospective cohort study in rural South-Western Uganda, 2004-2011. *Pan African Medical Journal*, *29*(1), 1-16.

Keith, A., Dong, Y., Shuter, J., & Himelhoch, S. (2016). Behavioral interventions for tobacco use in HIV-infected smokers: a meta-analysis. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *72*(5), 527-533.

Kyaw, N. T. T., Harries, A. D., Kumar, A. M., Oo, M. M., Kyaw, K. W. Y., Win, T., ... & Oo, H. N. (2017). High rate of virological failure and low rate of switching to second-line treatment among adolescents and adults living with HIV on first-line ART in Myanmar, 2005-2015. *PLoS One*, *12*(2), e0171780.

Laprise, C., de Pokomandy, A., Baril, J. G., Dufresne, S., & Trottier, H. (2013). Virologic failure following persistent low-level viremia in a cohort of HIV-positive patients: results from 12 years of observation. *Clinical infectious diseases*, *57*(10), 1489-1496.

Lee, K. S., Kim, H. J., & Yoon, S. W. (2022). Patient adherence and ART failure rates in South Korea: A retrospective study. *Journal of Korean Medical Science*, *37*(12), e159.

Lewis, J., Walker, A. S., Castro, H., De Rossi, A., Gibb, D. M., Giaquinto, C., ... & Callard, R. (2012). Age and CD4 count at initiation of antiretroviral therapy in HIV-infected children: effects on long-term T-cell reconstitution. *Journal of Infectious Diseases*, *205*(4), 548-556.

Matare, T., Shambira, G., Gombe, N., Tshimanga, M., & Bangure, D. (2015). Factors associated with human immunodeficiency virus first-line treatment failure in Zvishavane District, Zimbabwe, 2014. Austin Journal of HIV/AIDS Research, 2(1), 1010.

Mascolini, M. (2013) Antiretroviral Therapy: From Heart Risk Factor to Heart Protector? Aug 8, 2013.

Marinho, M., Mota-Oliveira, M., Peixoto, M. J., Marques, J., & Braganca, M. (2016). Depression among HIV-infected patients–a reality that must not be forgotten. *European Psychiatry*, *33*(S1), S526-S526.

McMahon, J. H., Jordan, M. R., & Cooper, D. A. (2016). TDR rapidly reverses the effectiveness of first-line ARV therapy at the population level in that individuals with TDR who begin ARV therapy with a lower genetic barrier to resistance have a higher risk of virological failure. *Journal of Infectious Diseases*, *213*(2), 295-303. https://doi.org/10.1093/infdis/jiv580

Moraka, N. O., Garcia-Broncano, P., Hu, Z., Ajibola, G., Bareng, O. T., Pretorius-Holme, M., ... & Shapiro, R. L. (2021). Patterns of pretreatment drug resistance mutations of very early diagnosed and treated infants in Botswana. *AIDS (London, England)*, *35*(15), 2413.

Murphy, R. A., & Schimel, D. (2012). Several NRTI-only regimens have been shown to have higher failure rates than currently preferred ART regimens. *Journal of Infectious Diseases*, *206*(6), 945-952. https://doi.org/10.1093/infdis/jis462

Naidoo, A., Naidoo, K., Yende-Zuma, N., Gengiah, T. N., Padayatchi, N., Gray, A. L., … Abdool Karim, S. S. (2014). Changes to antiretroviral drug regimens during integrated TB–HIV treatment: results of the SAPiT trial. *Antiviral Therapy*, *19*(2), 161–169.

NASCOP(2023) World AIDS Day Report 2022; It is a race against time. Accessed from https://nsdcc.go.ke/wp-content/uploads/2022/12/WAD-Report_F4-1.pdf

NASCOP (2022). Kenya HIV Prevention and Treatment Guidelines, 2022 accessed from https://www.nascop.or.ke/new-guidelines/

NASCOP (2022). Kenya ARV Guidelines, 2018 accessed from https://www.nascop.or.ke/new-guidelines/

Nation Media (2022). Kenya's war on HIV not all doom and gloom as infections drop by 78.2pc in 10 years. Accessed from https://nation.africa/kenya/news/kenya-hiv-infections-drop-in-10-years-4352432

Nasuuna, E., Kigozi, J., Babirye, L., Muganzi, A., Sewankambo, N. K., & Nakanjako, D. (2018). Low HIV viral suppression rates following the intensive adherence

counseling (IAC) program for children and adolescents with viral failure in public health facilities in Uganda. *BMC public health*, *18*, 1-9.

Natukunda, J., Kirabira, P., Ong, K. I. C., Shibanuma, A., & Jimba, M. (2019). Virologic failure in HIV-positive adolescents with perfect adherence in Uganda: a cross-sectional study. Tropical medicine and health, 47(1), 1-10.

Nega, J., Taye, S., Million, Y., Rodrigo, C., & Eshetie, S. (2020). Antiretroviral treatment failure and associated factors among HIV patients on first-line antiretroviral treatment in Sekota, northeast Ethiopia. AIDS Research and Therapy, 17, 1-9.

Neubert, J., Michalsky, N., Laws, H. J., Borkhardt, A., Jensen, B., & Lübke, N. (2017). HIV-1 Subtype diversity and prevalence of primary drug resistance in a single-center pediatric cohort in Germany. *Intervirology*, *59*(5-6), 301-306.

Newman, L. P., Pagkas-Bather, J., Njoroge, A., Wamalwa, D., Nduati, R., Overbaugh, J., & Farquhar, C. (2019). Virological failure in children living with HIV on antiretroviral therapy: correlates and predictive value of clinical measurements and CD4 cell count. International journal of STD & AIDS, 30(12), 1207-1213.

Njom Nlend, A. E., Motaze, A. N., Ndiang, S. T., & Fokam, J. (2017). Predictors of virologic failure on first-line antiretroviral therapy among children in a referral pediatric center in Cameroon. *The Pediatric Infectious Disease Journal*, *36*(11), 1067-1072.

Office of Aids Research (2023). Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents with HIV Retrived from https://clinicalinfo.hiv.gov/en/guidelines/hiv-clinical-guidelines-adult-and-adolescent-arv

Onywera, H., Maman, D., Inzaule, S., Auma, E., Were, K., Fredrick, H., ... & Zeh, C. (2017). Surveillance of HIV-1 pol transmitted drug resistance in acutely and recently infected antiretroviral drug-naive persons in rural western Kenya. *PloS one*, *12*(2), e0171124.

Palella Jr, F. J., Delaney, K. M., & Moorman, A. C. (2016).Factors associated with mortality among persistently viraemic triple-antiretroviral-class-experienced patients receiving antiretroviral therapy in the HIV Outpatient Study (HOPS). *Journal of Antimicrobial Chemotherapy*, *69*(10), 2826-2834.

Phillips, A. N., Dunn, D., & Cooper, D. A. (2016). An endemic TDR strain emanating from a single instance of ARV-selection pressure spreading among many individuals has different public health implications from TDR strains emanating from multiple independent episodes of ARV-selection pressure. *Lancet HIV*, *3*(10), e479-e487. https://doi.org/10.1016/S2352-3018(16)30111-6.

Pimentel, V., Pingarilho, M., Alves, D., Diogo, I., Fernandes, S., & Miranda, M.(2020). Molecular epidemiology of HIV-1 infected migrants followed up in Portugal: Trends between 2001-2017. Viruses.; 12 (3): 268.

Oluniyi, P. E., Ajogbasile, F. V., Zhou, S., Fred-Akintunwa, I., Polyak, C. S., Ake, J. A., ... & Happi, C. T. (2022). HIV-1 drug resistance and genetic diversity in a cohort of people with HIV-1 in Nigeria. *AIDS (London, England)*, *36*(1), 137.

Ranganathan, P., & Aggarwal, R. (2018). Study designs: Part 1–An overview and classification. *Perspectives in clinical research*, *9*(4), 184.

Rhee, S. Y., Blanco, J. L., Jordan, M. R., Taylor, J., Lemey, P., Varghese, V., ... & Shafer, R. W. (2015). Geographic and temporal trends in the molecular epidemiology and genetic mechanisms of transmitted HIV-1 drug resistance: an individual-patient-and sequence-level meta-analysis. *PLoS medicine*, *12*(4), e1001810.

Rhee, S. Y., Kantor, R., & Joseph, J. (2017). The global uptake of ART has resulted in significant reductions in HIV-1 mortality, lower mother-to-child transmission, and adult HIV-1 incidence. *Journal of Acquired Immune Deficiency Syndromes (JAIDS)*, *75*(4), 434-440. https://doi.org/10.1097/QAI.0000000000001405Michael, N., Katz, D. A., & McColl, D. J. (2013).

Adherence to medication therapy (ART) that is consistent and nearly perfect is deemed necessary for HIV positive patients to fully realize its life extending benefits. *HIV Medicine*, *14*(7), 411-418. https://doi.org/10.1111/hiv.12050

Rojas Sanchez, P., Domínguez, S., Jimenez De Ory, S., Prieto, L., Rojo, P., Mellado, P., ... & Holguín, Á. (2018). Trends in drug resistance prevalence, HIV-1 variants and clinical status in HIV-1-infected pediatric population in Madrid: 1993 to 2015 analysis. *The Pediatric Infectious Disease Journal*, *37*(3), e48-e57.

Ross, J., Chan, S., Vann, M., & Lee, J. (2021). Second-line treatment failure among HIV-positive individuals in Asia Pacific: A cross-sectional study. *Asia Pacific Journal of Public Health*, *33*(4), 456-465. https://doi.org/10.1177/10105395211013924

Ross, J., Jiamsakul, A., Kumarasamy, N., Azwa, I., Merati, T. P., Do, C. D., ... & Law, M. (2021). Virological failure and HIV drug resistance among adults living with HIV on second-line antiretroviral therapy in the Asia-Pacific. HIV medicine, 22(3), 201-211.

Rutherford, G. W., Anglemyer, A., Easterbrook, P. J., Horvath, T., Vitoria, M., Penazzato, M., & Doherty, M. C. (2014). Predicting treatment failure in adults and children on antiretroviral therapy: a systematic review of the performance characteristics of the 2010 WHO immunologic and clinical criteria for virologic failure. *Aids*, *28*, S161-S169.

Salou, M., Butel, C., Konou, A. A., Ekouevi, D. K., Vidal, N., Dossim, S., ... & Dagnra, A. Y. (2016). High rates of drug resistance among newly diagnosed HIV-infected children in the national prevention of mother-to-child transmission program in Togo. *The Pediatric infectious disease journal*, *35*(8), 879-885.

Sebunya, R., Musiime, V., Kitaka, S. B., & Ndeezi, G. (2013). Incidence and risk factors for first line anti-retroviral treatment failure among Ugandan children attending an urban HIV clinic. *AIDS research and therapy*, *10*, 1-10.

Shroufi, A., Van Cutsem, G., Cambiano, V., Bansi-Matharu, L., Duncan, K., Murphy, R. A., ... & Phillips, A. (2019). Simplifying switch to second-line antiretroviral therapy in sub Saharan Africa: predicted effect of using a single viral load to define efavirenz-based first-line failure. *AIDS (London, England)*, *33*(10), 1635.

Sithole, Z., Mbizvo, E., Chonzi, P., Juru, T. P., Shambira, G., Gombe, N. T., & Tshimanga, M. (2018). Virological failure among adolescents on ART, Harare City, 2017-a case-control study. *BMC infectious diseases*, *18*(1), 1-8.

Subronto, Y. W., Kusmayanti, N. A., Abdalla, A. S., & Sattwika, P. D. (2020). Nevirapine and tuberculosis predict first-line treatment failure in HIV patients in Indonesia: Case-control study. *Annals of Medicine and Surgery*, *60*, 56–60.

Takuva, S., Maskew, M., Brennan, A. T., Long, L., Sanne, I., & Fox, M. P. (2014). Poor CD4 recovery and risk of subsequent progression to AIDS or death despite viral suppression in a South African cohort. *Journal of the International AIDS Society*, *17*(1), 18651.

Tanyi, W. N., Gachuno, O., Odero, T., Farquhar, C., Kimosop, D., & Mayi, A. (2021). Factors affecting adherence to antiretroviral therapy among children and adolescents living with HIV in the Mbita Sub County Hospital, Homa Bay-Kenya. African Health Sciences, 21(1), 18-24.

Tufa, T. B., Fuchs, A., Orth, H. M., Lübke, N., Knops, E., Heger, E., ... & Feldt, T. (2022). Characterization of HIV-1 drug resistance among patients with failure of second-line combined antiretroviral therapy in central Ethiopia. HIV medicine, 23(2), 159-168.

Villabona-Arenas, C. J., Vidal, N., Guichet, E., Serrano, L., Delaporte, E., Gascuel, O., & Peeters, M. (2016). In-depth analysis of HIV-1 drug resistance mutations in HIV-infected individuals failing first-line regimens in West and Central Africa. *Aids*, *30*(17), 2577-2589.

Watt, M. H., Cichowitz, C., Kisigo, G., Minja, L., Knettel, B. A., Knippler, E. T., ... & Mmbaga, B. T. (2019). Predictors of postpartum HIV care engagement for women enrolled in prevention of mother-to-child transmission (PMTCT) programs in Tanzania. *AIDS care*, *31*(6), 687-698.

World Health Organization, (2016). *Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach*. World Health Organization.

Zaccarelli, M., Tozzi, V., Lorenzini, P., Trotta, M. P., Forbici, F., Visco-Comandini, U., ... & Collaborative Group for Clinical Use of HIV Genotype Resistance Test. (2005). Multiple drug class-wide resistance associated with poorer survival after treatment failure in a cohort of HIV-infected patients. *Aids*, *19*(10), 1081-1089.

Zenebe Haftu, A., Desta, A. A., Bezabih, N. M., Bayray Kahsay, A., Kidane, K. M., Zewdie, Y., & Woldearegay, T. W. (2020). Incidence and factors associated with treatment failure among HIV infected adolescent and adult patients on second-line antiretroviral therapy in public hospitals of Northern Ethiopia: multicenter retrospective study. PloS one, 15(9), e0239191.

Zenu, S., Tesema, T., Reshad, M., & Abebe, E. (2021). Determinants of first-line antiretroviral treatment failure among adult patients on treatment in Mettu Karl Specialized Hospital, South West Ethiopia; a case control study. PLoS One, 16(10), e0258930.

Zikmund, W. G., Babin, B. J., Carr, J. C., Adhikari, A., & Griffin, M. (2016). Business Research Method , Cengage Learning India Pvt. *Ltd. Delhi*.

APPENDICES

Appendix I: Research Data

Treatment outcome and marital status

Marital status	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
Never married	33	91.7%	3	8.3%	36	10.1%
Married	204	96.7%	7	3.3%	211	59.3%
Polygamous	31	91.2%	3	8.8%	34	9.6%
Separated	2	100.0%	0	0.0%	2	0.6%
Divorced	13	100.0%	0	0.0%	13	3.7%
Widowed	57	95.0%	3	5.0%	60	16.9%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	$\chi = 4.143$		df = 5		p = 0.529	

Treatment outcome and sex

Sex	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
Male	167	93.3%	12	6.7%	179	50.3%
Female	173	97.7%	4	2.3%	177	49.7%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	$\chi = 4.095$		df = 1		p = 0.043	

Treatment outcome and age

Age	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
21 to 30 Years	42	91.3%	4	8.7%	46	12.9%
31 to 40 Years	106	94.6%	6	5.4%	112	31.5%
41 to 50 Years	99	96.1%	4	3.9%	103	28.9%
51 to 60 Years	53	96.4%	2	3.6%	55	15.4%
61 to 70 Years	35	100.0%	0	0.0%	35	9.8%
Above 71 Years	5	100.0 %	0	0.0%	5	1.4%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	$\chi = 4.152$		df = 5		p = 0.028	

Treatment outcome and first regimen

First ART regimen	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
3TC+ABC+EFV	1	100.0%	0	0.0%	1	0.3%
3TC+AZT+NVP	32	97.0%	1	3.0%	33	9.3%
3TC+D4T+EFV	8	100.0%	0	0.0%	8	2.2%
3TC+D4T+NVP	81	96.4%	3	3.6%	84	23.6%
3TC+TDF+ATV/r	1	100.0%	0	0.0%	1	0.3%
3TC+TDF+DTG	11	73.3%	4	26.7%	15	4.2%
3TC+TDF+EFV	163	95.3%	8	4.7%	171	48.0%
3TC+TDF+LPV/r	1	100.0%	0	0.0%	1	0.3%
3TC+TDF+NVP	37	100.0%	0	0.0%	37	10.4%
3TC+AZT+EFV	4	1.2%	0	0.0%	4	1.1%
3TC+TDF+AZT	1	100.0%	0	0.0%	1	0.3%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 20.019		df = 10		p = 0.029	

Treatment outcome and WHO Stage

WHO stage	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
WHO Stage 1	102	96.2%	4	3.8%	106	29.8%
WHO Stage 2	99	97.1%	3	2.9%	102	28.7%
WHO Stage 3	129	95.6%	6	4.4%	135	37.9%
WHO Stage 4	10	76.9%	3	23.1%	13	3.7%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 11.161		df = 3		p = 0.011	

Time of ART and Treatment Outcomes

WHO stage	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
1 to 5 Years	23	82.1%	5	17.9%	28	7.9%
6 to 10 Years	126	96.9%	4	3.1%	130	36.5%
11 to 15 Years	102	94.4%	6	5.6%	108	30.3%
16 to 20 years	88	98.9%	1	1.1%	89	25.0%
More than 21 years	1	100.0%	0	0.0%	1	0.3%
Chi-square tests	χ = 14.943		df = 4		p = 0.005	

Treatment outcome and CD4 Cell count

CD4 cell count	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
>350 CD4 Cells	96	94.1%	6	5.9%	102	28.7%
<350 CD4 Cells	244	96.1%	10	3.9%	254	71.3%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 0.642		df = 1		p = 0.423	

Treatment outcome and Drug adherence

Adherence	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
Good	336	99.7%	1	0.3%	337	94.7%
Poor	1	9.1%	10	90.9%	11	3.1%
Inadequate	3	37.5%	5	62.5%	8	2.2%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 267.911		df = 2		p = 0.000	

Treatment outcome and Comorbidities

Comorbidities	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
None	330	99.4%	2	0.6%	332	93.3%
Tuberculosis	3	30.0%	7	70.0%	10	2.8%
Hypertension	1	50.0%	1	50.0%	2	0.6%
Diabetes	5	62.5%	3	37.5%	8	2.2%
Diabetes/Hypetension	1	25.0%	3	75.0%	4	1.1%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 187.959		df = 4		p = 0.000	

Treatment outcome and Alcohol used

Alcohol use	Success (<1000 cells)		Failure (>1000 cells)		Total	
	Frequency	%	Frequency	%	Frequency	%
No	325	98.5%	5	1.5%	330	92.7%
Yes	15	57.7%	11	42.3%	26	7.3%
Total	340	95.5%	16	4.5%	356	100.0%
Chi-square tests	χ = 93.433		df = 1		p = 0.000	

Appendix II: Ethical Approval

Telegrams: "MEDICAL", Kisumu
Telephone: 057-2020801/2020803/2020321
Fax: 057-2024337
E-mail: ercjootrh@gmail.com
When replying please quote

ERC.IB/VOL.1/445
Ref: .....

JARAMOGI OGINGA ODINGA TEACHING & REFERRAL HOSPITAL
P.O. BOX 849
KISUMU
4th May, 2018
Date.....

Nancy Egeizarh Mulati
Jomo Kenyatta University of Agriculture & Technology
TM 310-CO14-5002/2015

Dear Mulati,

RE: FORMAL APPROVAL TO CONDUCT RESEARCH ENTITLED:-
"PREDICTORS OF THE TREATMENT FAILURE AMONG HIV POSITIVE CLIENTS IN WEBUYE SUB-COUNTY, BUNGOMA COUNTY, KENYA"

The JOOTRH ERC reviewed your protocol and found it ethically satisfactory. You are therefore permitted to commence your study immediately. Note that this approval is granted for a period of one year (4th May , 2018 to 4th May, 2019). If it is necessary to proceed with this research beyond approved period, you will be required to apply for further extension to the Committee.

Also note that you will be required to notify the committee of any protocol amendment(s), serious of unexpected outcomes related to the conduct of the study or termination for any reason.

In case the study site is JOOTRH, kindly report to the Chief Executive Officer before commencement of data collection.

Finally, note that you will also be required to share the findings of the study in both hard and soft copies upon completion.

The JOOTRH – ERC takes this opportunity to thank you for choosing the Institution and wishes you the best in your endeavours.

Yours sincerely.

WILBRODA N.MAKUNDA
SECRETARY- ERC
JOOTRH - KISUMU