Prevalence and predictors of Virological non- suppression among key populations on HIV treatment in Zanzibar

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PREVALENCE AND PREDICTORS OF VIROLOGICAL NON-SUPPRESSION AMONG KEY POPULATIONS ON HIV TREATMENT IN ZANZIBAR

By

Khamis Bilal Ali

A Dissertation Submitted in (Partial) Fulfillment of the Requirement for the Degree of Master of Science (Epidemiology and Laboratory Management) of

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: **"Prevalence and predictors of virological non-suppression among key populations on HIV treatment in Zanzibar'',** in (partial) fulfillment of the requirement for the degree of Master of Science (Epidemiology and Laboratory Management) of the Muhimbili University of Health and Allied Sciences.

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(Supervisor)

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(Supervisor)

Date: _____

DECLARATION AND COPYRIGHT

I, **Khamis Bilal Ali**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other university for similar or any other degree award.

Signature…… **Date**……..

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Finally, with much love am thankfully to my beloved wives Ms Aisha and Ms Asila for their love, tolerance, encouragement and support during the whole busy time of my study despite the hard time.

DEDICATION

This dissertation is dedicated to my lovely wives, sons, daughters and grandchildren of Mrs. Maryam Nassor for their moral support during my study.

ABSTRACT

Background: Key populations (KPs) account for quarter of all new HIV infections in sub-Saharan Africa. In Tanzania, 14.9% of HIV infected adults in the general population are not virally suppressed. Given the high burden of HIV among KPs, it is imperative to understand the extent of virological non-suppression among these marginalized groups.

Aim: To determine the prevalence and predictors of virological non-suppression among female sex workers (FSW), people who inject drugs (PWIDs), and men who have sex with other men (MSM) on first line antiretroviral therapy (ART) in Zanzibar.

Methods: This was a retrospective cross sectional study that involved review of medical records of HIV infected FSW, PWID and MSM who were initiated ART between January 2016 to December 2018. All key populations who had viral load results after six months of using ART were included in the study. Prevalence of virological non-suppression was calculated from proportion of KPs with plasma RNA levels above 1000 copies/ml among all KPs with viral load results after six month of ART. Proportion of treatment failure was a number of participants who remained unsuppressed out of all who received enhanced adherence counseling (EAC). Logistic regression was used to identify factors that predicted virological non-suppression among key populations. A two sided p-value <0.05 were considered statistical significant**.**

Results: Of the 174 key populations enrolled into the study, 29/174 (16.7%) were virological unsuppressed after six month of ART. Virological non-response was highest among MSM 26.1%, followed by PWID 22.2% and FSW 12.3%. Nearly half (44.5%) of all unsuppressed KPs progressed to virological treatment failure. In adjusted analyses; poor medication adherence and non-disclosure of HIV status were independently associated with virological non-suppression in all groups. The odds for virological non–suppression among FSW, PWIDs and MSM with poor adherence were; OR=5.5 (95%CI: 2.1-14.6), OR=4.8 (95% CI: 1.7-13.3) and OR=5.1 (95% CI: 1.4-18.6) respectively. Similarly, the odds of virological non-response among FSW, PWIDs and MSM with non-disclosure status were;

OR=4.5 (95% CI: 0.7-27.4), OR=1.7 (95% CI: 0.7-17.4), and OR=1.8 (95% CI: 0.5-11.3) respectively. TB co-infection increased the odds of virological non-suppression among PWIDs, OR=4.4, (95% CI: 0.9-22.0).

Conclusion: Viral non-suppression rates among key population in Zanzibar are higher above UNAIDS targets. Poor adherence and non-disclosure of a positive HIV status are significant predictors of virological non-suppression among key populations.

TABLE OF CONTENTS

CERTIFICATION i
DECLARATION AND COPYRIGHT ii
ACKNOWLEDGEMENT iii
DEDICATION iv
ABSTRACT v
TABLE OF CONTENTS vii
LIST OF TABLES x
LIST OF FIGURES xi
LIST OF ABBREVIATIONS xii
OPERATIONAL DEFINITIONS xiv
CHAPTER ONE 1
1.0 INTRODUCTION 1
1.1 Background 1
1.2 Problem statement 3
1.3 Rationale of the study 3
1.4 Conceptual Framework 4
1.5 Research question 6
1.6 Study objectives 6
1.6.1 Broad objective 6
1.6.2 Specific objectives 6
CHAPTER TWO 7
2.0 LITERATURE REVIEW 7
2.1 HIV infection among key populations 7

2.2 Burden of virological non-suppression among patients on antiretroviral therapy 7
2.3 Predictors of virological non-suppression in patients on antiretroviral therapy 9
CHAPTER THREE 11
3.0 METHODOLOGY 11
3.1 Study design and study area 11
3.2 Study Population 11
3.3 Sampling procedure 12
3.4 Sample size estimation 12
3.5 Study variables 14
3.5.1 Dependent variable 14
3.5.2 Independent variables 14
3.6 Data collection 15
3.7 Data analysis 15
3.8 Ethical consideration 15
CHAPTER FOUR 17
4.0 RESULTS 17
4.1 Socio- demographic characteristics of the study participants 17
4.2 Clinical characteristics of the study population 18
4.3 Proportion of virological non-suppression among key populations 19
4.4 Proportion of KPs with virological treatment failure after enhanced adherence counseling 20
4.5 Predictors of virological non-suppression among female sex workers 20
4.6 Predictors of virological non-suppression among people who injects drugs 22
4.7 Predictors of virological non-suppression among men who have sex with other men 23

CHAPTER FIVE 25

5.1 Discussion 25

5.2 Recommendations 28

REFERENCE 29

APPENDICES 40

Appendix 1: Data extraction tool 40

Appendix 2: Ethical clearance letter 41

Appendix 3: Research permit 42

Appendix 4: Permission to conduct health research 43

Appendix 5: Permission letter 44

LIST OF TABLES

Table 1: Socio-demographic characteristics of the study participants 17

Table 2: Clinical characteristics of the study participants 18

Table 3: Univariable and multivariable analysis of the factors associated with virological non-suppression among female sex workers 21

Table 4: Univariable and multivariable analysis of the factors associated with virological non-suppression among people who injects drugs 23

Table 5: Univariable and multivariable analysis of the factors associated with virological non-suppression among men who sex with other men. 24

LIST OF FIGURES

Figure 1: A conceptual framework illustrating predictors associated with virological non-supression among FSW, MSM, and PWID on ART. 5

Figure 2: Flow chart showing how participants were included in the study 12

Figure 3: Proportion of unsuppressed FSW, PWIDs and MSM 19

Figure 4: Proportion of FSW, PWIDs, and MSM who failed treatment 20

LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
CD4	Cluster of Differentiation 4
CDC	Center for Disease and Control
CI	Confidence Interval
CTC	Care and Treatment Centers
EAC	Enhanced Adherence Counseling
FSW	Female Sex Workers
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
HVL	HIV Viral Load
IDUs	Injecting Drug Users
KCMH	Kidongo Chekundu Mental Hospital
KPs	Key Populations
MAT	Methadone Assisted Therapy
MMH	Mnazi Mmoja Hospital
MSM	Men who have Sex with Men

MUHAS	Muhimbili University of Health and Allied Sciences
NACP	National AIDS control program
PCR	Polymerase Chain Reaction
PLWHIV	People Living With HIV/AIDS
PWID	People Who Inject Drugs
RNA	Ribonucleic Acid
TB	Tuberculosis
TFELTP	Tanzania Field of Epidemiology and Laboratory Training Program
THIS	Tanzania HIV Impact Survey
UNAIDS	United Nations Program on HIV/AIDS
VL	Viral Load
WHO	World Health Organization
ZAHRI	Zanzibar Health Research Institute
ZAYEDESA	Zanzibar Youth Education Environment Development Support Association
ZIHHTLP	Zanzibar Integrated HIV, Hepatitis, TB and Leprosy Program

OPERATIONAL DEFINITIONS

Virological non-suppression: Viral load above 1000 copies/ml after six months of antiretroviral therapy use (World Health Organization, Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection, 2016).

Virological treatment failure: Persistently detectable viral load exceeding1000 copies/ml on two consecutive viral load measurements within a 3-month interval with adherence support between measurements after at least 6 months of using ART (World Health Organization: Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection, Recommendations for a public health approach - Second edition, 2016).

Enhanced adherence counseling: Counseling given to HIV clients with a high viral load (above 1000 copies/ml) after being on ART for six months or more in order to assess possible barriers to adherence and help the client to achieve viral suppression (Ministry of Health, Zanzibar national guidelines for the prevention and treatment of HIV and AIDS, 2017)

HIV drug resistance: Ability of HIV to mutate and reproduce itself in the presence of antiretroviral drugs (Thaczuk et al, PLoS ONE, 2015)

Key populations: Groups of people that are at increased risk of HIV irrespective of the epidemic type or local context. They include men who have sex with men, people who inject drugs, sex workers and adolescent girls and young women (World Health Organization, Consolidated guidelines on HIV prevention, diagnosis, treatment and care for key populations, 2016)

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

United Nations Program on HIV and AIDS (UNAIDS) estimated that 36.9 million people in the world were living with HIV in 2017 (1), with Sub-Saharan Africa being the most affected region (2). Despite the scale up of access to antiretroviral drugs, almost 2 million people became newly infected with HIV in 2017, with nearly half of all new infections occurring among key populations and their sexual partners (3,4). Outside Sub-Saharan Africa, key populations and their sexual partners accounted for 80% of new HIV infections in 2016. In sub-Saharan Africa, they were responsible for a quarter of all new HIV infections in 2016 (5). Comparing to general population, the risk of acquiring HIV is 28 times higher in men who have sex with men (MSM), 22 times higher among people who inject drugs (PWID), and 13 times higher for female sex workers (FSW) (6,7).

Success in suppressing HIV viral load has led to a dramatic reduction in transmission of HIV from mother to child, and among sero-discordant couples (8). To end the AIDS epidemic by 2030, UNAIDS aims to have 90% of all HIV infected individuals on ART achieve viral load suppression by 2020 (9). To achieve this goal, World Health Organization (WHO) introduced routine viral load testing for all patients on ART (10). Viral load testing monitors effectiveness of ART, provide early warning of treatment failures (11), identifies patients in need of more intensive adherence support and minimizes chances of development of drug resistance (10). In 2018, 79% of all people living with HIV knew their status, among those who knew their status, 78% were on treatment, and among those on ART, 86% were virally suppressed (12). Presence of resistant HIV strains prior to initiation of treatment, high baseline viral load, CD4 cell count below 350 cells/mm^3 at diagnosis, poor adherence to medication, non-disclosure, and young age have been associated with non-suppression among HIV infected adults in general population (13,14).

In Tanzania, 68% of HIV infected adults in the general population were receiving antiretroviral treatment (6). A quarter of these (27%) were virally unsuppressed in 2017 (1,6). Although key populations in Tanzania mainland and Zanzibar are disproportionately affected by HIV, the extent of virological non-suppression among these marginalized groups is largely unknown. This study aims to partly fill the gap by assessing the prevalence and predictors associated with virological non-suppression among FSW, MSM, and PWIDs in Zanzibar.

1.2 Problem statement

Unlike in mainland Tanzania, where the HIV epidemic is generalized, in Zanzibar it is mainly concentrated among key populations. While the prevalence of HIV in the general population is around 1%, it is 19.3% among FSW, 11.3% among PWIDs, and 2.6% among MSM (15,16). Having multiple sexual partners, inconsistent condom use, illicit drug use, stigma, discrimination, social isolation, criminalization, and poor access to health services were main factors that increased vulnerability of FSW, PWID, MSM to HIV infections (17–20). Given the high burden of HIV among key populations and their role in driving the AIDS epidemic, it is imperative to understand the extent of virological non-suppression among these marginalized groups and identify factors that are associated with virological non-suppression six months after initiation of anti-retroviral treatment. This study aimed to estimate the proportion of virological non-suppressed FSW, PWIDs and MSM in Zanzibar and identify predictors of viral non-suppression.

1.3 Rationale of the study

Establishing the magnitude and factors associated with virological non-suppression will help in early identification of patients who are likely to fail treatment. This will improve monitoring of high-risk group to ensure treatment efficacy. Furthermore, early detection of treatment failure among FSW, PWIDs, and MSM is crucial to curbing the rate of HIV transmission among key and general populations. It will also lead to timely switching of antiretroviral treatment that will prevent development of multidrug resistant HIV strains, slow progression to AIDS, and reduce AIDs associated mortality.

1.4 Conceptual Framework

Various factors have been found to be associated with virological non-suppression in HIV patients receiving first line ART. Poor medication adherence were significant predictors of unsuppressed viral load due to low treatment efficacy and missing of ART dose (21–23). Non -disclosure of HIV positive status to at least one family member or sexual partners were significantly associated with non-suppression due to lack of treatment supporter and stigma (24,25).

Distance from home to health facility can have an interaction with medication adherence factors like dose frequency and missed appointments hence leading to treatment failure (21,23,26). TB co-infection during ART has multiple effects including drug-drug interaction, pill burden and overlapping toxicities associated with non-suppression (21–23).

Low baseline BMI (< 18.5) and negative or no change in weight have weakened immunity and blunted immune response and increased risk of treatment failure (21–23). Young age below 30 years, may predicts non-suppression due to poor adherence to treatment than older age (27–29).

Having a low baseline CD4 count (<200 cells/mm^3) and advanced WHO clinical stage were significant predictors of non-suppression due to frequent occurrence of opportunistic infections that leads to disease progression subsequently increased risk of treatment failure rather than WHO stage I and II were less likely to unsuppressed due to high immunity of the body (21,30).

Being unmarried increased the risk of virological unsuppression (27–29). Sex was not associated with non-suppression, however in resource-limited settings males have unsuppressed viral load than the female because males have poor health-seeking behaviors and enhanced poor adherence to treatment and ART regimen change were predictors of non-suppression due to early resistance mutation and poor regular monitoring of HIV patients on antiretroviral treatment (3,4,21).

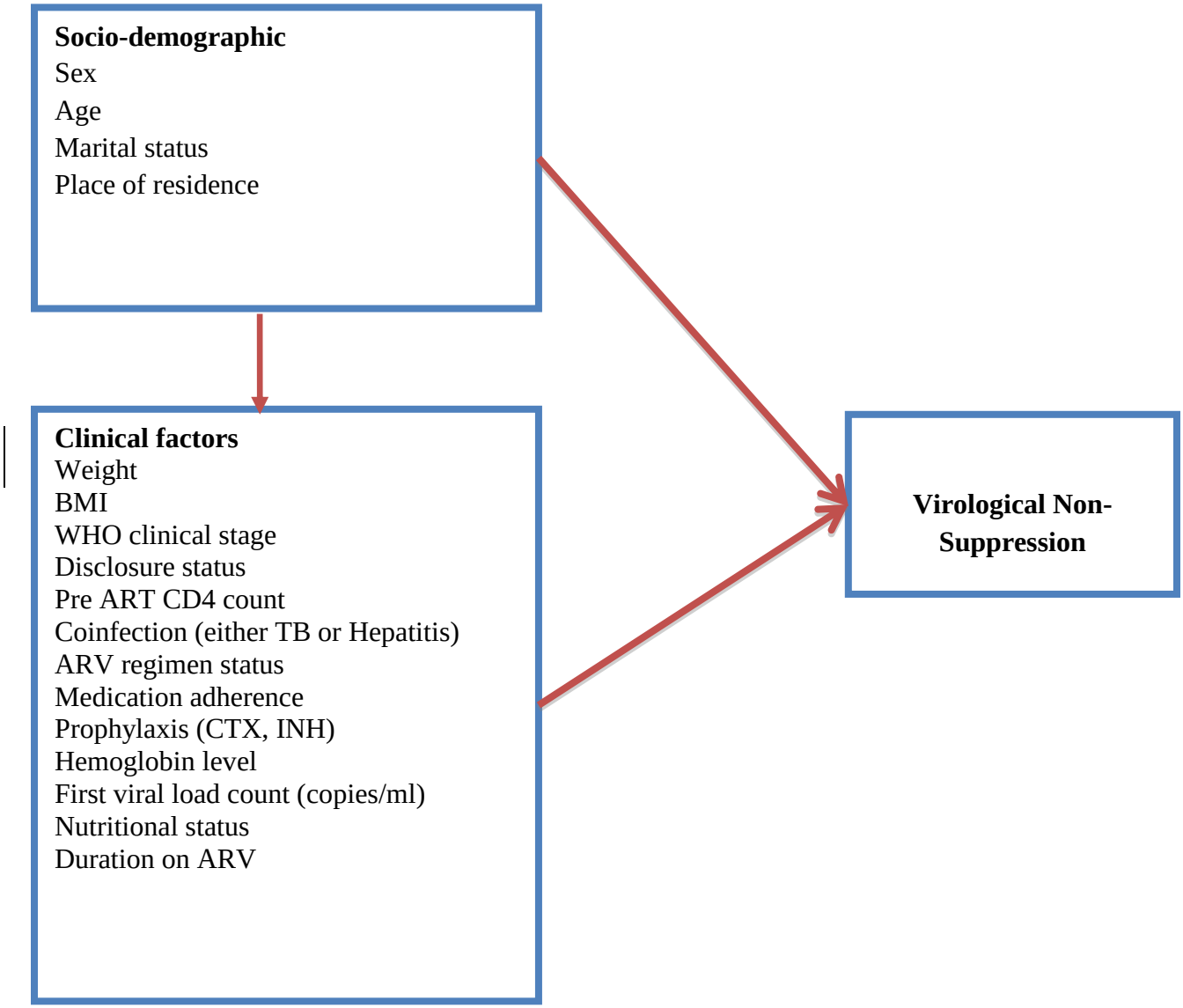


Figure 1: A conceptual framework illustrating predictors of virological non-supression among FSW, MSM, and PWID on ART.

1.5 Research question

1. What is the magnitude of virological non-suppression among key populations on first line ART in Zanzibar?

1.6 Study objectives

1.6.1 Broad objective

- To determine the prevalence and predictors of virological non-suppression among key populations on HIV treatment in Zanzibar.

1.6.2 Specific objectives

1. To determine proportion of unsuppressed FSW, PWID, and MSM six months after initiation of HIV treatment.
2. To determine proportion of FSW, PWID, and MSM with virological failure after enhanced adherence counseling.
3. To identify predictors of virological non-suppression among FSW, PWID, and MSM on ART.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HIV infection among key populations

Key populations remain among the most vulnerable to HIV. In 2017, more than 90% of new HIV infections in Eastern Europe, central Asia, Middle East and North Africa and 16% of new HIV infections in Eastern and Southern Africa occurred among key populations (31,32). Globally, the risk of HIV infection among FSW, MSM, and PWIDs is 10 to 50 times higher than in general population (33). UNAIDS reports that new HIV infections among gay men are rising and there is no reduction of new infections among sex workers, people who use drugs and prisoners (1,34). In 2017, MSM accounted for 57% of new HIV infections in virological non-suppression Western Europe and North America, 41% in Latin America and the Caribbean, 25% in Asia and the pacific and the Caribbean, 20% in eastern Europe and central Asia and the Middle East and North Africa, and an estimated 12% in western and central Africa (35,36). Globally, sex workers make up 9% of the total number of new HIV infections (34,37). In southern Africa HIV prevalence is 10–20 times higher among sex workers than among adults in the general population, with rates of HIV infection among sex workers reaching 50% in Lesotho, Malawi, South Africa and Zimbabwe (31,32). It estimated that one in ten new HIV infections are caused by the sharing of needles (6,38), and 13.1% of 11.8 million people who inject drugs worldwide are living with HIV (39,40). Eastern Europe and Central Asia, saw a 29% increase in new HIV infections between 2010 and 2017, with 40% of them occurring among PWIDs (41).

2.2 Burden of virological non-suppression among patients on antiretroviral therapy

At the end of 2017, 59% of all people living with HIV were accessing treatment (42,43). There is clear evidence that HIV treatment is so effective that it eliminates risk of sexual transmission of the virus from infected individuals with an undetectable viral load in their blood (44–46). This was demonstrated in sero-discordant heterosexual and MSM couples in which HIV-positive partners on suppressive ART did not transmit infection to their HIV

negative partners after 76,991 condom less sex acts (47). Thus, to end the HIV epidemic, UNAIDS wants 90% of all HIV infected people on antiretroviral drugs to achieve viral suppression by 2020 (48). Globally, 81% all HIV infected individuals on ART are virally suppressed (34). Key populations and their sexual partners are the main drivers of the HIV epidemic worldwide (1). Therefore, achieving virological suppression among these groups will decrease the spread of HIV and greatly accelerate gains that will reverse the HIV epidemic (2) . However, in many countries, key populations are pushed to the fringes of society by stigma and the criminalization of same-sex relationships, drug use and sex work. Marginalization, including discrimination in the health sector, limits access to effective HIV services (49,50)**.** Studies conducted in South Africa and Thailand revealed that less than 30% of MSM are on HIV treatment unlike in developed countries where more than 60% are accessing treatment (51). Available evidence shows that provision of health services to key populations in a stigma and discrimination free environment significantly increases uptake of antiretroviral drugs and reduces new HIV infections (45,52,53). A 73% decrease in HIV sero-prevalence was observed from 2006 to 2012 in St Petersburg, Russia, when injecting drug users were engaged in HIV prevention efforts in their own communities (54,55).

A large gap exists between antiretroviral coverage and viral suppression (1,34). In Sub-Saharan Africa, 60% of adults living with HIV are accessing treatment, but more than a quarter of them are not achieving virological suppression (56). In some countries the failure rates are very high. In Gabon, 41.3% of adults on antiretroviral therapy are not achieving viral suppression (57), while in South Africa 48.1% of FSW were virally unsuppressed (58). High rates of virological non-suppression have also been reported in PWIDs using antiretroviral drugs. In China, 20.8% of PWID are failing to achieve viral suppression (59), while in North America and Europe non-suppression among injecting drug users ranges between 30-45% (60). Studies in Brazil and United Kingdom reveal a huge difference in non-suppression among MSM living with HIV in rich and middle-income countries. Virological non-suppression among MSM in Brazil is three times higher than in United Kingdom, 61.8% and 21% respectively (61,62).

2.3 Predictors of virological non-suppression in patients on antiretroviral therapy

The previous studies have demonstrated the predictors of virological non suppression varied considerably across population and setting with respect to demographic, psychological, behavioral and economic factors. In China studies have reported that being patients less than 30 were more significantly more likely to experience elevated viral load than older patients (62). A 67.0% unsuppressed viral load has been observed compared to 36.4% among those with more than 30 years of age (62). Other predictors including sex, educational level, place of residence, body mass index (BMI), co-infection with tuberculosis, low adherence and baseline CD4 counts were not associated to failure (21–23). Other studies suggests that first line ART adherence rates of 95% may be needed to suppress viral replication and to avoid development of HIV drug resistance (63,64). Being single and unemployed increase the risk of unsuppressed an evidence show that 64.3% of unmarried HIV patients fail to achieve viral suppression compared to 47.9% of married couples or those with partners (62). Similarly, virological non-suppression is lower among those with reliable 44.1%, than in unemployed HIV patients (60.7%) (55). The risk of unsuppressed is seven times higher in patients with poor adherence to treatment than their counterparts (67–70). Low baseline CD4 cell count (<200/mm3), high pre-treatment viral load. Similarly, patients with advanced HIV infection (WHO stage 3& 4) were more likely to develop antiretroviral treatment failure compared with early stage of HIV infection (21,30). TB co-infection, ongoing drug use, depression, stigma, incarceration, and unstable housing conditions have been seen to increase the risk of unsuppressed viral load among PWIDs and gay men (4,59,71). Several studies have been done in African Countries including Ethiopia, Gabon and South Africa have demonstrated that age at start ART, current age, TB status, gender, lack of social support, active drug alcohol use, non-disclosure, poor adherence, low duration on ART, pregnancy and prior ART exposure were predictors of antiretroviral first line treatment failure (57,72,73). Other factors, ranging from the patient to the external environment can impact both retention, adherence and leads to unsuppressed viral load.

Easter African Countries including Uganda and Tanzania previous studies showed young age, poor adherence, having active tuberculosis, low CD4 counts, body mass index (BMI), hemoglobin, higher WHO clinical stage, low level of education, gender, stigma, inadequate referral system and poor access to treatment center and were associated with antiretroviral treatment failure among adults clients on first line treatment (22,30,74).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design and study area

This was a retrospective cross-sectional study which involved a review of medical records of HIV infected FSW, PWIDs and MSM. To determine prevalence of treatment failure, records of participants with unsuppressed viral loads were reviewed at three months after EAC. The study was conducted at three care and treatment clinics (CTC) in Zanzibar; Mnazi Mmoja Hospital (MMH), Zanzibar Youth Education Environment Development Support Association (ZAYEDESA) and Kidongo Chekundu Mental Hospital Methadone Assisted Therapy (KCMH-MAT) clinics. These are the main clinics that provide HIV services to key populations in Zanzibar. Medical records were reviewed from February to May 2019.

3.2 Study Population

In Zanzibar, routine monitoring of HIV viral load began in 2016. Therefore, this involved all FSW, PWIDs and MSM enrolled into CTC between January 2016 and December 2018. Eligible participants were all KPs with documented viral load results after six months of antiretroviral treatment. Individuals with missing viral load results and those on antiretroviral drugs for less than six months were excluded from the study.

Selection of participants' records

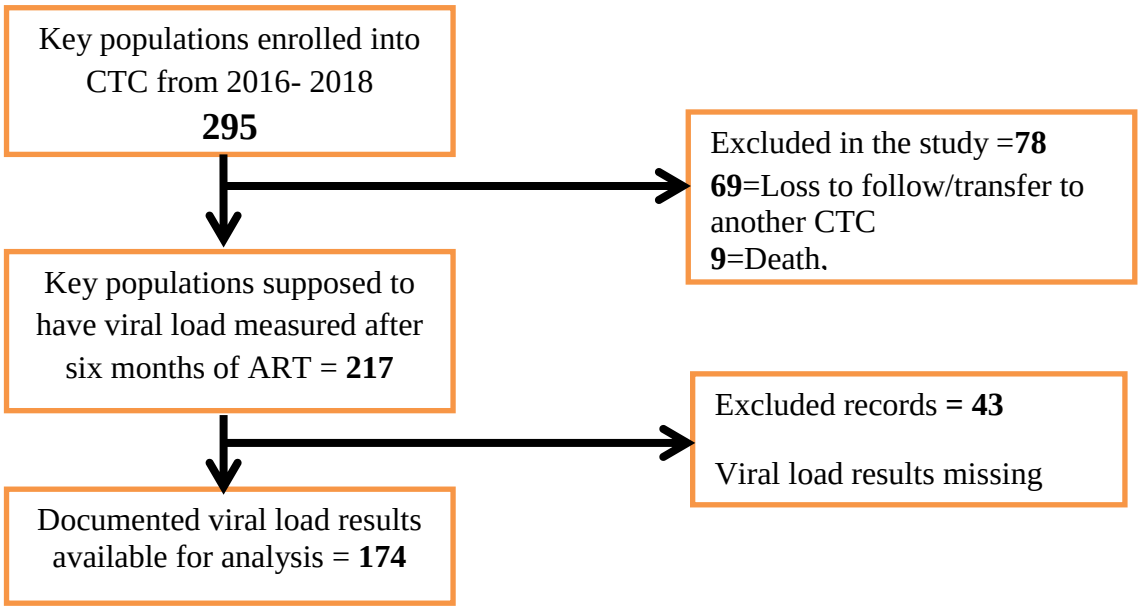


Figure 2: Flow chart showing how participants were included in the study

3.3 Sampling procedure

Data were extracted from Hospital database and CTC 2 cards. All available records that fulfilled the inclusion criteria were reviewed. Proportion of virological non-suppression was calculated as a number of KPs with plasma RNA levels above 1000 copies/ml among all KPs with viral load results. Proportion of treatment failure was a number of participants who remained unsuppressed out of all who received enhanced adherence counseling (EAC).

3.4 Sample size estimation

i) For determining the prevalence of virological non-suppression among key populations we used a formula in Niang *et al*, 2006 (75).

$$n = Z^2 p [1-p] / \varepsilon^2$$

Whereby:

n = the minimum estimated sample size

Z = Z score for 95% Confidence Interval (1.96)

P = 14 % (0.14) proportion of virological non-suppression among female sex workers in Malawi (76).

ε^2 = 5% (0.05)

Therefore:

n = $(1.96)^2$ x 0.14 x (1-0.14)/1.92 = 185 participants

The minimum sample size required to get the prevalence of key population with unsuppressed viral loads is 185

ii) For determining predictors of virological non- suppression, we used Fleiss formula to estimate the sample size (Fleiss et al, 1981) (65).

$$N_{Fleiss-cc} = \frac{N_{Fleiss}}{4}\left[1 + \sqrt{1 + \frac{2(r+1)}{N_{Fleiss} r |p_1 - p_0|}}\right]$$

Whereby:

$$N_{Fleiss} = \frac{\left[Z_{\frac{\alpha}{2}}\sqrt{(r+1)p(1-p)} + Z_{\beta}\sqrt{rp_0(1-p_0) + p_1(1-p_1)}\right]^2}{r(p_0 - p_1)^2}$$

$Z_{\alpha/2}$ = 1.96= standard normal deviate for two-tailed test based on alpha level (relates to the 95% confidence interval level)

Z_{β}= 0.84= standard normal deviate for one-tailed test based on beta level (relates to the power level) = 80%

α = The probability of type I error = 0.05

β = The probability of type II error = 0.2

P_0 =The proportion of virological non-suppression in clients with incomplete adherence = 32% (3).

P_1 =The proportion of virological non-suppression in clients with complete adherence = 10% (3).

r = The ratio of number of clients with complete adherence to incomplete adherence = 5

Therefore:

$$p = \frac{p_0 + rp_1}{r + 1}$$

$$p = \frac{0.32+5\times0.1}{5+1} = 0.137$$

$$N_{Fleiss} = \frac{[1.96\sqrt{(5+1)0.137(1-0.137)} + 0.84\sqrt{5(0.32)(1-0.32)+0.1(1-0.1)}]^2}{5(0.32-0.1)^2}$$

$$N_{Fleiss} = 27.12$$

$$N_{Fleiss-cc} = \frac{27.12}{4}[1 + \sqrt{1 + \frac{2(5+1)}{27.12 \times 5(0.32-0.1)}}]$$

$$N_{Fleiss-cc} = 34$$

=34 is the number of clients with incomplete adherence

The required number of clients with complete adherence is 34x5= 170

The minimum sample size needed to get factors associated with virological non-response in key population was 204

We used the bigger sample size 204, which was sufficient to determine both prevalence and factors associated with virological non-suppression.

3.5 Study variables

3.5.1 Dependent variable

The dependent variable was virological non-suppression

3.5.2 Independent variables

The independent variables were socio-demographic factors like sex, age, marital status, place of residence and clinical factors such as Body mass index, WHO clinical stage, baseline CD4 count, disclosure status, TB co-infections, medication adherence, and viral load count.

3.6 Data collection

Viral load results and other socio-demographic and clinical information stated in section 3.5.2 were extracted from CTC 2 database and verified by using CTC 2 cards (appendix 1). The CTC 2 cards are data collection tools that have been approved by the Ministry of Health in Zanzibar and Mainland Tanzania for capturing information in HIV program in the country. Extracted data were checked for completeness, duplication, and other errors before being analyzed.

3.7 Data analysis

Collected data were analyzed using the STATA version 15.1. Descriptive analysis was carried out using frequency and proportion for categorical variables and means and standard deviations for continuous variables. Proportion of virological non- suppression was calculated as a number of KPs with unsuppressed viral loads among all KPs with documented viral load results after six months of antiretroviral treatment**.** Prevalence of virological failure was obtained from KPs with unsuppressed viral load after enhanced adherence support out of all KPs that received EAC. Logistic regression was used to identify predictors of virological non-suppression. All predictors with p-value $\leq$ 0.25 in the univariable analysis were entered into multivariable analysis by using stepwise logistic regression. A two sided p-value <0.05 were considered statistical significant**.**

3.8 Ethical consideration

Ethical clearance was obtained from Senate Research and Publication Committee of Muhimbili University of Health and Allied Sciences (MUHAS). Permission to conduct study was granted by the second vice president office, Zanzibar Health Research Institutes (ZAHRI), Mnazi Mmoja hospital, KCMH-MAT CTC clinics and ZAYADESA. Permission to use CTC2 database was obtained from Ministry of Health Zanzibar (Zanzibar Integrated HIV, Hepatitis, TB and Leprosy Programme) through ZAHRI.

Information obtained from CTC2 database was treated with utmost confidentiality and access to information was restricted to authorized personnel only. All data were stored in a password-protected computer and patients were identified by using study numbers.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio- demographic characteristics of the study participants

Viral load results from174 KPs were available for analysis. Of these, 106/174 (61%) were FSW, 45/174 (26%) were PWIDs and 23/174 (13%) were MSM. The mean age of the study participants were 33±8 years, with most of PWIDs (80%) and MSM (74%) being above 30 years of age. More than a third of all PWIDs 18/45 (40%) and MSM 9 (39.1%) were married compared to a quarter 27/106 (25.5%) in FSW. Socio-demographic results are shown in Table 1.

Table 1: Socio-demographic characteristics of the study participants

Variable	**Key population groups**		
	FSW (n =106)	**PWID (n=45)**	**MSM (n=23)**
	n (%)	**n (%)**	**n (%)**
Age (years)			
≤30	47(44.3)	9(20.0)	6(26.1)
≥30	59(55.7)	36(80.0)	17(73.9)
Sex			
Female	106(100.0)	5(11.1)	-
Male	-	40(88.9)	23(100.0)
Marital status			
Single	79(74.5)	27(60.0)	14(60.9)
Married	27(25.5)	18(40.0)	9(39.1)
Place of residence			
Urban	91(85.9)	42(93.3)	18(78.3)
Rural	15(14.1)	3(6.7)	5(21.7)

4.2 Clinical characteristics of the study population

Majority of key populations (>70%) started antiretroviral treatment in early stages of the disease and had higher CD4 levels at the time of treatment initiation. Compliance to HIV treatment was good in all groups except in PWIDs, in whom one-third poorly adhered to treatment. However, non-disclosure of positive HIV status was very high among study participants, 92% among FSW, 91% among MSM, and 78% in PWIDs. TB co-infection was more common among PWIDs than in FSW and MSM. Additionally, most of the PWIDs (72%) were malnourished compared to FSW and MSM. Table 2 summarizes clinical characteristics of study participants.

Table 2: Clinical characteristics of the study participants

Variable	Key population group		
	FSW (n =106), n (%)	**PWID (n =45), n (%)**	**MSM (n =23), n (%)**
BMI			
Under weight (<18.5kg/m2)	45(42.9)	31(72.1)	13(59.1)
Normal weight(18.5-25.0kg/m2)	49(46.8)	12(27.9)	8(36.4)
Over weight(>25.0 kg/m2)	11(10.5)	-	1(4.6)
WHO clinical stage			
Stage 1	71(67.0)	18(40.0)	13(56.5)
Stage 2	20(18.9)	14(31.1)	7(30.4)
Stage 3	13(12.3)	12(26.7)	2(8.7)
Stage 4	2(1.9)	1(2.2)	1(4.4)
Baseline CD4			
≤350 cells/mm³	9(9.7)	9(21.4)	4(20.0)
≥350 cells/mm³	84(90.3)	33(78.6)	16(80.0)
TB co-infection			
No	105(99.1)	37(82.2)	22(95.7)
Yes	1(0.9)	8(17.8)	1(4.3)
Medication adherence			
Poor	10(9.4)	17(37.8)	4(17.4)
Good	96(90.6)	28(62.2)	19(82.6)
Disclosure status			
No	98(92.4)	35(77.8)	21(91.3)
Yes	8(7.6)	10(22.2)	2(8.7)

4.3 Proportion of virological non-suppression among key populations

In general, the proportion of unsuppressed key populations in Zanzibar was higher than target set by UNAIDS. A total of 29/174 (16.7%, 95% CI: 11.8-23.0) were unsuppressed six months after initiation of ART. Non-suppression was higher among MSM 6/23 (26.1%, 95% CI: 9.1-40.4**)** followed by PWIDs 10/45 (22.2%, 95% CI: 18.9-54.3) and FSW 13/106 (12.3%, 95% CI: 27.2-63.9). The results are shown in figure 3.

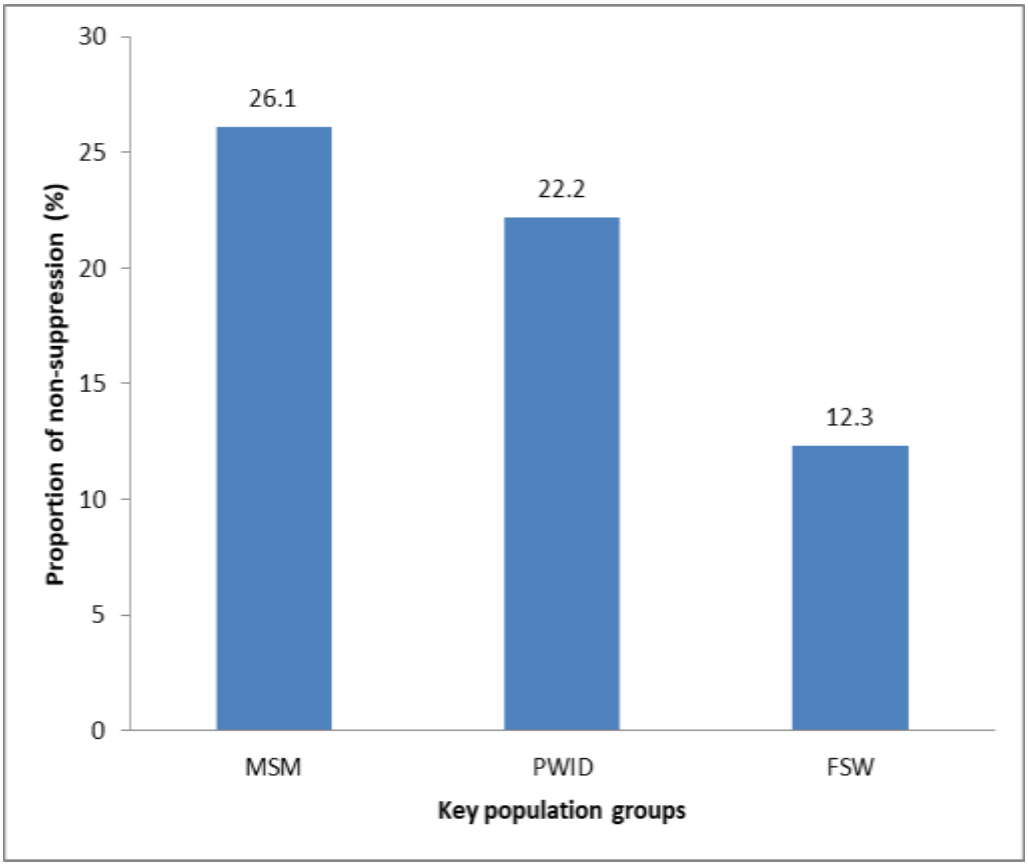


Figure 3: Proportion of unsuppressed FSW, PWIDs and MSM

4.4 Proportion of KPs with virological treatment failure after enhanced adherence counseling

Nearly half 13/29 (44.8%, 95% CI: 36.1-72.8) of all unsuppressed key populations progressed to treatment failure. More than half of PWID (60%, 95% CI: 19.5-75.2) failed treatment, whereas one-third of FSW (38.5%, 95% CI: 14.6-69.5) and MSM (33.3%, 95% CI: 30.8-51.0) failed virological (Figure 4).

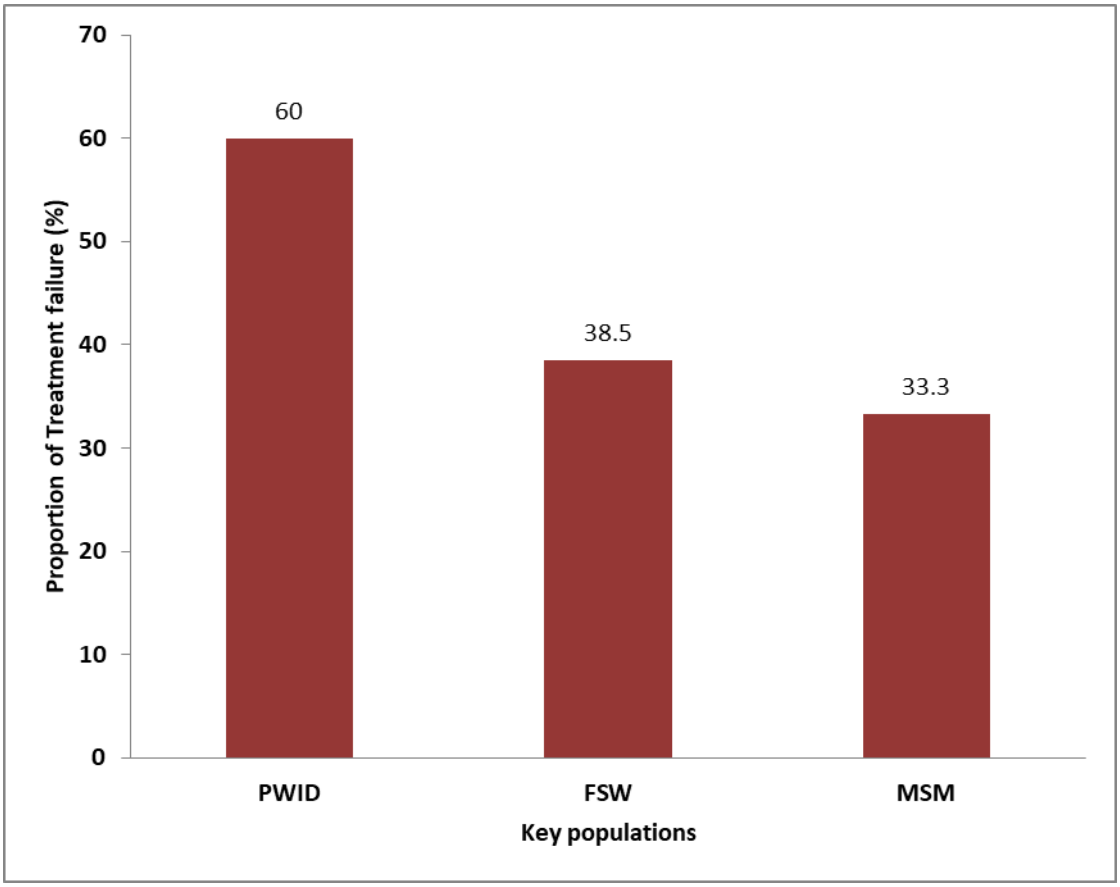


Figure 4: Proportion of FSW, PWIDs, and MSM who failed treatment

4.5 Predictors of virological non-suppression among female sex workers

Poor adherence to treatment and failure to disclose a positive HIV status were significant predictors of virological non-suppression in FSW. In multivariate analysis, the odds of being virological unsuppressed were six times higher among FSW with poor adherence than

in those with good compliance, OR=5.5 (95% CI: 1.4-18.6, p= 0.014). Similarly, FSW who did not reveal their positive HIV status were five times more likely to be unsuppressed compared to those who had disclosed their HIV status to at least one family member, OR=4.5 (95% CI: 0.7-27.4), p= 0.004. Age, marital status, baseline CD4 count, BMI, and WHO clinical stage were not associated with virological non-suppression in FSW. A summary of predictors is provided in table 3.

Table 3: Univariable and multivariable analysis of the factors associated with virological non-suppression among female sex workers

Variable	Unsuppressed viral load	Suppressed viral load	cOR (95%CI)	P-value	aOR (95%CI)	P-value[a]
Age (years)						
≤30	5(38.5)	42(45.2)	1		1	
≥30	8(61.5)	51(54.8)	1.3(0.4-4.3)	0.649	1.3(0.4-4.3)	0.619
Marital status						
Single	9(69.2)	70(75.3)	0.7(0.2-2.6)	0.641		
Married	4(30.8)	23(24.7)	1			
BMI						
<18.5kg/m2	7(58.3)	38(40.9)	2.1(0.5-7.3)	0.273		
18.5-25.0kg/m2	4(33.3)	45(48.4)	1			
≥25.1 kg/m2	1(8.3)	10(10.8)	1.1(0.1-11.2)	0.920		
WHO clinical stage						
Stage I	7(53.8)	64(68.8)	**1**		**1**	
Stage II	4(30.8)	16(17.2)	2.3(0.6-8.8)	0.228	1.5(0.5-4.5)	0.426
Stage III	2(15.4)	11(11.8)	1.7(0.3-9.1)	0.557	1.6(0.5-5.5)	0.463
Stage IV	-	2(2.2)	-			
Baseline CD4						
≤350 cells/mm³	1(9.1)	8(9.8)	0.9(0.1-8.2)	0.944		
≥350 cells/mm³	10(90.9)	74(90.2)	**1**			
Disclosure status						
No	11(84.6)	87(93.6)	2.6(0.5-14.7)	0.249	4.5(0.7-27.4)	0.004
Yes	2(15.4)	6(6.4)	**1**		**1**	
Medication adherence						
Poor	4(30.8)	6(6.5)	6.4(1.5-27.2)	0.011	5.5(1.4-18.6)	0.014
Good	9(69.2)	87(93.5)	**1**		**1**	

cOR=crude odd ratio, aOR= adjusted odd ratio , p-value[a] = p-value for adjusted odd ratio.

4.6 Predictors of virological non-suppression among people who injects drugs

Like in FSW, poor adherence to treatment and non-disclosure of a positive HIV status were also independent predictors of virological non-suppression in PWIDs. In adjusted analysis likelihood of virological unsuppression was five times higher among PWIDs with poor medication adherence than their counterparts, OR=4.8 (95% CI: 1.7-13.3), p=0.002. Likewise, non-disclosure of a positive HIV status significantly increased the chances of virological unsuppression among PWIDs, OR=1.7 (95% CI: 0.7-17.4), p=0.032. Additionally, co-infection with pulmonary tuberculosis increased the odds of virological non-suppression four folds in PWIDs, OR=4.4 (95% CI: 0.9-22.0), p=0.073. Baseline CD4 count, BMI, WHO clinical stage, age and marital status did not influence non-suppression in PWDIs (Table 4).

Table 4: Univariable and multivariable analysis of the factors associated with virological non-suppression among people who injects drugs

Variable	Unsuppressed viral load	Suppressed viral load	COR (95%CI)	P.value	AOR (95%CI)	P-value[a]
Age (years)						
≤30	3(30.0)	6(17.1)	1		1	
≥30	7(70.0)	29(82.9)	0.5(0.1-2.4)	0.376	1.3(0.4-4.2)	0.619
Sex						
Female	1(10.0)	4(11.4)	1		1	
Male	9(90.0)	31(88.6)	1.2(0.1-11.7)	0.899	1.3 (0.1-18.1)	0.864
Marital status						
Single	7(70.0)	20(57.1)	1.8(0.4-7.9)	0.467		
Married	3(30.0)	15(42.9)	1			
BMI						
<18.5 kg/m2	7(70.0)	24(72.7)	0.9(0.2-4.1)	0.866		
18.5-25.0 kg/m2	3(30.0)	9(27.3)	1			
WHO clinical stage						
Stage 1	1(10.0)	17(48.6)	1		1	
Stage 2	4(40.0)	10(28.6)	6.8(0.7–69.6)	0.106	1.3(0.5-4.1)	0.577
Stage 3	4(40.0)	8(22.9)	8.5(0.8 – 88.9)	0.074	1.3(0.3-4.6)	0.724
Stage 4	1(10.0)	-	-			
Baseline CD4						
≤350 cells/mm³	3(30.0)	6(18.8)	1.9(0.4-9.4)	0.453		
≥350 cells/mm³	7(70.0)	26(81.2)	1			
TB co-infection						
No	6(60.0)	31(88.6)	1		1	
Yes	4(40.0)	4(11.4)	5.2(1.0 – 26.5)	0.049	4.4(0.9-22.0)	0.073
Disclosure status						
No	5(50.0)	30(85.7)	2.5(1.3 – 18.5)	0.024	1.7(0.7-17.4)	0.032
Yes	5(50.0)	5(14.3)	1		1	
Medication adherence						
Poor	7(70.0)	10(28.6)	5.8(1.3-27.2)	0.025	4.8(1.7-13.3)	0.002
Good	3(30.0)	25(71.4)	1		1	

cOR=crude odd ratio, aOR= adjusted odd ratio , p-value[a]= p-value for adjusted odd ratio.

4.7 Predictors of virological non-suppression among men who have sex with other men

Virological non-suppression in MSM was significantly associated with poor compliance to treatment and failure to disclose their positive HIV status. In multivariate analysis the odds of non-suppression were five times higher in MSM with poor adherence to treatment OR=4.7 (95% CI: 1.6-14.0) p=0.005. The likelihood of virological non-suppression

increased significantly when MSM did not reveal their positive HIV status to anyone, OR=1.8 (95% CI: 0.5-11.3), p=0.035. Like in other key populations; age, marital status, baseline CD4 count, BMI, and WHO clinical stage, did not predict virological non-suppression in MSM (Table 5).

Table 5: Univariable and multivariable analysis of the factors associated with virological non-suppression among men who sex with other men.

Variable	Unsuppressed viral load	Suppressed viral load	COR (95%CI)	P. value	AOR (95%CI)	P. value[a]
Age in years						
≤30	1 (16.7)	5 (29.4)	1		1	
≥30	5 (83.3)	12 (70.6)	2.8 (0.2-22.7)	0.547	1.3 (0.4-4.2)	0.619
Marital status						
Single	6 (100.0)	8 (47.1)				
Married	-	9 (52.9)	1	-		
BMI						
<18.5kg/m2	3 (60.0)	10 (58.8)	0.9 (0.1-7.0)	0.920		
18.5-25.0kg/m2	2 (40.0)	6 (40.0)	1			
≥25.0 kg/m2	-	1 (5.9)				
WHO clinical stage						
Stage1	4 (66.7)	9 (52.9)	1			
Stage 2	1 (16.7)	6 (35.3)	0.4 (0.0-4.2)	0.427		
Stage 3	1 (16.7)	1 (5.9)	2.3 (0.1-45.7)	0.598		
Stage 4	-	1 (5.9)	-			
Baseline CD4						
≤350 cells/mm³	2 (50.0)	2 (12.5)	7.0 (0.6-81.7)	0.121	1.8(0.5-6.5)	0.369
≥350 cells/mm³	2 (50.0)	14 (87.5)	1		1	
Disclosure status						
No	5 (83.3)	16 (94.1)	1.3 (0.1-5.9)	0.239	1.8(0.5-11.3)	0.035
Yes	1 (16.7)	1 (5.9)	1		1	
Medication adherence						
Poor	2 (33.3)	2 (11.8)	3.8 (0.4-35.5)	0.249	4.7(1.6-14.0)	0.005
Good	4 (66.7)	15 (82.2)	1		1	

cOR=crude odd ratio. aOR= adjusted odd ratio , p-value[a] = p-value for adjusted odd ratio.

CHAPTER FIVE

5.1 Discussion

This study aimed to determine the extent of virological non-suppression among key populations on first line ART in Zanzibar. We found an overall prevalence of 16.7%, higher than UNAIDS target of less than 10%. Proportion of non-suppression was highest among men having sex with men (26.1%), followed by injecting drug users (22.1%), and female sex workers (12.3%). Virological treatment failure was high, occurring in nearly half of all key populations. Poor adherence to medication and failure to disclose their positive HIV status were significant predictors of virological non-suppression among all groups. Additionally, co-infection with pulmonary tuberculosis was found to increase the likelihood of virological unsuppressed among injecting drug users.

In our study, the proportion of virological unsuppressed among men having sex with men (MSM) and people who inject drugs (PWIDs) was twice that of female sex workers (FSW). Although all key populations are marginalized in society there is high level of discrimination against MSM in Zanzibar (77). Lugalla J *et al*, (2007) found that there was a denial about existence MSM in Zanzibar, because it is against the values of all religions on the island (77). This may affect access to treatment among members of this group, leading to high levels of virological non-suppression. An effective ART decreases plasma viral load levels and enhance immune recovery (25). In this study, adherence to medication was poorer among PIWDs than other groups, increasing the proportion of virological non-suppression in this group. Additionally, the small size of PWIDs subpopulation on ART may have influenced the high proportion seen in this group. Furthermore, TB co-infection among people on ART is known to increase the chances of non-suppression due to drug interaction (78,79). The proportion of virological non-response among FSW observed in our study is similar to results reported in Malawi and Uganda, in which 14% and 9% of FSW on first line ART are reported to be unsuppressed (76,80). Huet C, *et al* (2011) also demonstrated high levels of virological non-suppression in Burkinafaso, where a quarter of MSM were not virological suppressed after six months of ART (50). The proportion of

virological non-response among PIWDs in our study is substantially lower than reported in China (59), where 48.1% of all injecting drug users were virological non-responsive. The small proportion of PIWDs with virological non-response in our study could be influenced by small number of participants in our study.

We also found that half of unsuppressed key populations developed treatment failure. This high rate of treatment failure has also been reported among key populations in South Africa, and Malawi, where 48.2% and 55% of FSW failed virological (58,81). However in Uganda only one-fifth (20.8%) of FSW are reported to be failing virological (80). The high failure rate in our study could be also contributed by drug resistance mutations which we could not assess resistance testing was done to participants.

In this study, non-disclosure of HIV positive status and poor adherence to medication were independent predictors of virological non-suppression among all groups. HIV infected patients are highly stigmatized in Zanzibar (77). An impact assessment reported by Lugalla J *et al* ,(2007) revealed that 43% tourism sector workers would be ashamed to be seen with a person living with HIV (PLHIV), because they believed that PLHIVs must have been promiscuous and 37% feel that they should bear the consequences (77). This high level of stigma in the society is a key driver of non-disclosure among key populations. Failure to disclose a positive HIV status has also been demonstrated elsewhere to major barrier to virological non-suppression (18,82–85). Detection of more than 1000 copies/ml of viral RNA after more than six months of ART use is an indication of either poor adherence or drug resistance mutations (86). Similar findings were reported in a study by Gebrezgabher *et al,* (2017) that timely identification of viremia crucial to reinforcing adherence before the development of resistance (87). In this study, tuberculosis co-infection increased the odds of virological non-suppression among PWIDs. Pulmonary tuberculosis is one of the leading causes of death among HIV patients on ART in sub-Saharan Africa (88).

Previously, it has been shown that young age (below 30), having a low baseline CD4 count (<200 cells/mm^3), and being unmarried increased the risk of virological unsuppressed (27–29). In this study, majority (64.5%) of participants were older patients, above 30 years of age, and more than 75% had higher CD4 levels (>350 cells/mm$^{3)}$ at the beginning of treatment. Thus, age and baseline CD4 count were not found to be associated with failure to achieve virological suppression. However, being unmarried increased the odds of virological non-suppression among injecting drug users, while showing a trend to decrease the odds in among female sex workers.

One alarming observation we found was that one-fifth of enrolled key populations did not measure HIV viral load six months after initiation of treatment. This indicated poor retention of key populations in care and treatment clinics. This is worrisome since a high loss to follow up can lead to further spread of HIV and emergence of HIV drug resistance. A similar observation has previously been reported in a systematic review, in which 20% of FSW were reported to be lost from care and treatment clinics (89,90).

Small sizes of subpopulation groups in our study may limit our ability to generalize the findings. Our study involved the use of secondary data, which meant we could not interview participants or collect blood specimens. Lack of an opportunity to interview participants limited our ability to collect more information like condom use, stigma and discrimination. Failure to collect blood specimens restricted our ability to perform laboratory tests to identify mutations that are associated with HIV drug resistance and to characterize HIV strains circulating among key affected populations in Zanzibar. Additionally, missing records also reduced the sample size in our study.

In conclusion, we found high levels of virological non-suppression and treatment failure among key populations in Zanzibar. Poor adherence and non-disclosure of a positive HIV status are significant predictors of virological non-suppression among key populations.

5.2 Recommendations

We recommend the following to reduce virological non-suppression and prevent treatment failure.

- To strength adherence counseling and encourage key populations to disclose their positive HIV status to reduce the chances of virological non-suppression
- We should perform drug resistance tests to identify mutations that can lead to treatment failure.
- Further studies are needed to find out reasons for high loss to follow up of key populations at care and treatment clinics.

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APPENDICES

Appendix 1: Data extraction tool

TITTLE: PREVALENCE AND DETERMINANTS OF VIROLOGICAL FAILURE AMONG KEY POPULATIONS ON HIV TREATMENT IN ZANZIBAR																					
S.NO	Client CTC ID	Age	S ex	Marital status	Place of residence	Weight (kg)	WHO clinical stage	Disclosure status	Baseline CD4 count (cells/mm3)	Co infection	ART regimen used	Medication adherence	Height (m^2)	HB level	First viral load results (copies/ml)	Second viral load results (copies/ml)	Body mass index	Duration on ART	Name of CTC	KP categories	Remarks

Appendix 2: Ethical clearance letter

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
DAR ES SALAAM
TANZANIA
Web: www.muhas.ac.tz

Tel G/Line: +255-22-2150302/6 Ext. 1015
Direct Line: +255-22-2151378
Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. DA.287/298/01A/ 19th March, 2019

Mr. Khamis Bilal Ali
MSc. Epidemiology and Laboratory Management
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED: "PREVALENCE AND DETERMIONANTS OF VIROLOGICAL FAILURE AMONG KEY POPULATIONS ON HIV TREATMENT IN ZANZIBAR 2019"

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from 19th **March, 2019 to 18th March, 2020.** In case you do not complete data analysis and dissertation report writing by **18th March, 2020,** you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Public Health and Social Sciences, MUHAS

Appendix 3: Research permit

REVOLUTIONARY GOVERNMENT OF ZANZIBAR

SECRETARY
ZANZIBAR RESEARCH COMMITTEE
P. O Box 239
Tel: 2230806
FAX: 2233788



RESEARCH/FILMING PERMIT
(This Permit is only Applicable in Zanzibar for a duration specified)

SECTION

Name:	**Khamis Bilal Ali**
Sex	Male
Date and Place of Birth	7 July, 1976
Nationality:	Tanzanian
Passport Number:	-
Date and Place of Issue	-
Date of arrival in Zanzibar	-
Expected date of departure	-
Duration of study	Six Months
Research Tittles:	Prevalence and Determinates of Biological Failure among key Population on HIV Treatment in Zanzibar 2019

Full address of Sponsor: Ministry of Health Elderly Gender and Women

This is to endorse that I have received and duly considered applicant's request I am satisfied with the descriptions outlined above.

S. M. Z

Name of the authorizing officer:	Mwanaisha A. Khamis
Signature and seal:	
Institution:	Office of Chief Government Statistician
Address:	P. O Box 2321 Zanzibar.
Date:	**29/03/2019**

Appendix 4: Permission to conduct health research

ZANZIBAR HEALTH RESEARCH INSTITUTE

Ministry of Health Zanzibar, P.O. Box 236, Vuga Zanzibar
Tel: +255 772 605 560 Fax: +255-24-2231613
Email: info@zahri.org Website: http://www.zahri.org

Ref: NO.ZAHREC/02/APR/2019/16 04th April, 2019

Mr. Khamis Bilal Ali
Student Researcher.

PROTOCOL TITLE: Prevalence and determination of virological failure among key populations on HIV treatment in Zanzibar.

RE: ETHICAL CLEARENCE FOR CONDUCTING HEALTH RESEARCH IN ZANZIBAR:

This to certify that research protocol entitled "**Prevalence and determination of virological failure among key populations on HIV treatment in Zanzibar**" was received and reviewed by the Zanzibar Health Research Ethical Committee (ZAHREC) on April, 2019.

We would like to inform you that the decision of the committee to this protocol was "Approved".

The permission to undertake data collection is for one year beginning from the date of this letter.

The principal investigators have to provide progress report after six months and final report to the Zanzibar Health Research Institute.

Seek permission to publish your findings from ZAHRI.

Any change made to the protocol need to be submitted to the ZAHREC for approval prior to its implementation.

Thanks in advance,

Dr. Mayassa S. Ally,
DIRECTOR GENERAL,
ZANZIBAR HEALTH RESEARCH INSTITUTE,
ZANZIBAR.

Dr. Jamala A. Taib,
DIRECTOR GENERAL,
MINISTRY OF HEALTH,
ZANZIBAR.

Appendix 5: Permission letter

HOSPITALI YA MNAZI MMOJA ZANZIBAR

Simu Namba: + 255 24 223 19 87
Nukushi : + 255 24 223 19 87
Barua pepe: mmrefhospital@hotmail.com

Wizara ya Afya
S. L. Posta 672
Zanzibar

Kumbu Na: MMH/274/2019

Tarehe: 11 Aprili 2019

Nd. Khamis B. Ali
Chuo kikuu cha Muhimbili
Dar es salaam

KUH: UTAFITI "KUANGALIA TATHMINI YA VIASHIRIA VINAVYOSABABISHA KUTOKUSHUKA KWA KIWANGO CHA MAAMBUKIZI YA VIRUSI VYA UKIMWI KWA MAKUNDI HATARISHI WANAOTUMIA DAWA ZA KUPUNGUZA MAKALI YA VVU ZANZIBAR"

Mada ya hapo juu inahusika na barua hii.

Ombi lako la kukusanya taarifa za matumizi ya dawa na hali ya ugonjwa huu kwa makundi hatarishi wanaohudhuria klinik ya CTC Mnazi mmoja na CTC ya MAT Kidongo chekundu na limepokewa na kuzingatiwa. Ruhusa imetolewa kuja au kuleta wasaidizi wako kwa ajili ya udadisi huo kuanzia tarehe ya barua hii hadi Oktoba 2019.

Unatakiwa kuwasilisha matokeo ya utafiti wako ofisini kwa Mkurugenzi Mtendaji mara baada ya kazi ya uandishi wa ripoti hiyo kumalizika na kuwasilisha kwenye Taasisi husika.

Unatakiwa kuvaa kitambulisho chako/wasaidizi wako muda wote wa kazi hii kwenye maeneo ya hospital. Pia uwe na kopi ya barua hii pamoja na barua ya ridhaa kutoka Baraza la Utafiti la Wizara ya Afya. Kutokana na upungufu wa wafanyakazi hospitalini hapa huruhusiwi kutumia wafanyakazi wa hospital kwa kazi yako hii.

Natanguliza shukurani za dhati kwa mashirikiano

MNAZI MMOJA HOSPITAL * Date..... * ZANZIBAR

Mwinyi I. Msellem
/Mkurugenzi mtendaji
Hospitali Mnazi mmoja,
Zanzibar

Nakla:

- Mkurugenzi, Huduma za Tiba –HMM
- Daktari dhamana. Klinik ya CTC ya MAT Kidongo chekundu
- Daktari dhamana. Klinik ya CTC ya Mnazi mmoja HMM