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Nwogo Ekeji
nwogo.ekeji@waldenu.edu

Nwogo Immaculata Ekeji
Walden University, ekejiimmacu@yahoo.com

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2021

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Nwogo Immaculata Ekeji

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Tolulope Osoba, Committee Chairperson, Public Health Faculty
Dr. Hebatullah Tawfik, Committee Member, Public Health Faculty
Dr. Mehdi Agha, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2021

Abstract

Relationship between Treatment Comorbidities and Viral Suppression of HIV Infections in Johannesburg

By

Nwogo Immaculata Ekeji

MPH, University of South, 2010

BSc. Health Education

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

In Public Health-Community Health Education

Walden University

November 2021

Abstract

HIV has globally infected 37.9 million people, of which 23.3 million (62%) are on antiretroviral treatment (ART). In South Africa, low rate of viral suppression among people living with HIV (PLWHIV) is a major health problem that has continued to fuel HIV persistence. A cross-sectional quantitative research design was used to investigate the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who were diabetic, had cancer, or tuberculosis (TB) in Johannesburg. The HIV care continuum formed the framework for this research. A secondary dataset from the national level survey 2017 was used for the descriptive and logistic regression analyses that were conducted. The results revealed a statistically significant association between TB treatment and viral suppression (adjusted OR=1.534, (1.053, 2.234), and p= 0.02, indicating that treatment of comorbidities such as TB has a positive impact on viral suppression outcomes. The results revealed that medical bills paid by medical aid were associated with viral suppression (OR= 1.789, (1.082, 2.957), p= 0.02. However, the model for diabetes treatment and viral suppression (OR=0.993 (0.658, 1.498), p=0.97), and the model for cancer treatment and viral suppression (OR= 1.234, (0.844, 1.805), p=0.27, revealed no significant associations. These findings indicate that concurrent, simultaneous, or integrated treatment models of comorbidities can help in achieving viral suppression. This study contributes to positive social change by highlighting the effect of the treatment of comorbidities on viral suppression in PLWHIV in an under-resourced setting, which could inform policy and influence decisions on HIV care and management.

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Dedication

This dissertation is dedicated to Jehovah almighty God whose everlasting grace enabled me to achieve my dream. To my Late father Mr. Everistus Elluh; may your gentle soul rest in peace amen.

Acknowledgments

I acknowledge my husband; Mr. Uzoma Ekeji for his encouragement and support throughout this study. A big thank you to my four children Pearl, Paschal, Pretty, and Pretorius for their understanding, love, and patience during this study because I was not able to give them the proper attention that they deserve.

I am deeply indebted to my chair; Dr. Tolulope Fadeke Osoba for her commitment, guidance, support, and love which has led to the attainment of my dream. I am also thankful to my second member; Dr. Hebatullah Tawfikwhose methodology expertise has helped in the proper alignment of this study.

To my mother, Mrs. Theresa Elluh, I am most grateful. Your love and support have continued to encourage me to go further. I also give special thanks to all who helped me with dataset access at the HSRC South Africa for all their assistance.

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Chapter 1: Introduction to the Study

Introduction

This research was an investigation into the relationship between treatment of comorbidities (such as cancer, diabetes, or tuberculosis (TB) and viral suppression among adults aged between 18 and 49 who were infected with HIV in Johannesburg South Africa. Research conducted by Ayah (2018) showed that adherence to antiretroviral treatment “ART” may result in viral load suppression. However, it was not clear if the existence and treatment of comorbidities such as diabetes, cancer, or tuberculosis influenced viral suppression. Hence the primary research question for this study was, does any relationship exist between treatments of comorbidities such as diabetes, cancer, or tuberculosis, and viral suppression among HIV positive adults aged 18 – 49 in Johannesburg South Africa?

In this study, I examined the effect of the treatment of comorbidities on viral suppression in HIV patients in an under-resourced setting. I addressed the gap in the public health literature on the relationship between treatment of comorbidities and viral suppression in HIV patients in Johannesburg South Africa. The findings of this study positively influence health care decisions relating to the health conditions of South Africans who need to co-treat other infections and HIV. The study contributes to the body of knowledge in the field of public health on associations between the treatment of comorbidities such as cancer, diabetes, or TB and viral load suppression among HIV-infected adults aged 18 – 49.

The major sections of this chapter include the introduction, problem statement, and purpose of the study. It also addresses the theoretical framework, research questions and hypotheses, nature of the study, definitions of the independent and dependent variables, the definition of terms, assumptions, scope and delimitations, and the summary. Viral load suppression reduces HIV transmission and HIV prevalence rates (Fonsah et al., 2017).

Problem Statement

HIV has globally infected 37.9 million people, of whom 23.3 million (62%) are on ART (United Nations Programme on HIV/AIDS (UNAIDS) 2016). Antiretroviral treatment has been shown to effectively suppress viral load and viral transmission (Kay et al., 2016; UNAIDS, 2016). However, insufficient viral load suppression is a major problem in the HIV care continuum in South Africa. HIV has continued to mount pressure (burden) on South Africa's workforce, economy, growth and development, population and GDP (UNAIDS, 2016) despite government, individual and organizational efforts to combat the disease. The rate of viral load suppression among adults aged 18 – 49, is influenced by non-adherence to treatment, interruption of treatment, and loss to follow-up of patients enrolled for treatment and these factors have been suggested to contribute to high mortality and morbidity of people infected with HIV in South Africa (Ekeji, 2016; Galea et al., 2018; StatsSA, 2017).

Viral load suppression is still low at 47%and HIV persists in South Africa (UNAIDS, 2019) despite the evidence that HIV testing, enrollment to treatment, retention in care, and treatment adherence have shown tremendous improvement in achieving viral suppression, reducing viral transmission, preventing virologic failure, and reversing mortality and morbidity related to the infection (Vreeman et al., 2018; Win et al., 2017).

The fact remains that ART can suppress human immune virus indefinitely to undetectable levels in blood such that PLWHIV with undetectable viral load have no risk of transmitting HIV to their HIV-negative sexual partners (Kay et al., 2016); however, it does not make ART a cure for the infection. HIV sustains long-lived reservoirs in the infected persons, which rapidly resurges if treatment is discontinued; no matter the magnitude of suppression achieved with anti-retro viral treatment (Centers for Disease Control and Prevention (CDC), 2014).

Irrespective of the fact that South Africa has the largest HIV treatment program in the world, the country has only met the first UNAIDs 2020 90% target of being aware of one's HIV status, the second target (PLHIV receiving treatment) and the third target (PLHIV viral load suppression) were at 61% and 47%respectively at the time of this study. The number of people living with HIV in South Africa is still high at seven million two hundred thousand (UNAIDS, 2019) which still gradually increases.

A study conducted by Chang et al. (2019) found that hypertensive or diabetic patients with other cardiometabolic problems are more likely to progress through the care continuum than those without cardiometabolic issues. Chang et al. (2019) also suggested that further research will improve understanding of the impact of different types of multimorbidity on health outcomes and the use of health services by both people living with HIV, health care providers, and public health practitioners.

In a study by Ayah (2018), TB was one of the most common comorbidities associated with a high level of loss to follow-up and early mortality among HIV patients. Myburgh et al. (2020) pointed out that South Africa is one of the countries in the world with the highest tuberculosis burden; with 78 thousand related deaths due to complications of treatment of comorbidities and management of TB and HIV in 2017. Ernesha et al. (2016) reported that non-adherence to concurrent treatment was more likely to be among patients with extra pulmonary tuberculosis and undisclosed HIV status. In the study of Ernesha et al. (2016) patients co-infected with TB and HIV, were more likely to adhere to TB treatment compared to ART.

Dhokotera et al. (2019) stated that Kaposi Sarcoma, cervical cancer and non-Hodgkin lymphoma, conjunctival cancer, vulva, and human papilloma virus are associated with HIV/AIDS and the linkage is largely based on co-infections with oncogenic viruses and poor access to HIV care. Conversely, Dhokotera et al. (2019) stated that people living with HIV do not have an increased risk of certain cancers such as breast, prostate, and colon compared with HIV-negative people. This infers that not all types of cancer are related to immune suppression.

Manne□Goehler et al. (2019) suggested that diabetic or hypertensive patients with cardiometabolic conditions tend to get better treatment for index conditions more than patients without cardiometabolic conditions but added that further investigation is needed to confirm the study findings. There was a mixed finding in the study of Manne□Goehler et al. (2019). HIV-infected patients with multimorbidity were found not to progress beyond diagnosis in the continuum of care when compared to HIV-infected patients without multimorbidity. Thus, they suggested using longitudinal data to test the effectiveness of various models of integrated care on HIV and cardiometabolic disease outcomes over time. However, little was known about the relationship between treatment of comorbidities and viral suppression of HIV infection in Johannesburg (Chang et al., 2019; Manne□Goehler et al., 2019), which motivated this research.

This study highlights the effect of frequent interaction of South Africans who need to co-treat other infections and HIV with the health care system, as in the hospital or clinic visits for routine treatment or check-up. This research has filled the gap in the public health literature on the relationship between treatment of comorbidities such as cancer, diabetes, or TB and viral suppression in Johannesburg South Africa. It positively influences the health decisions of South Africans who need to co-treat other infections and HIV.

This research positively contributes to social change by highlighting the effect of the treatment of comorbidities on viral suppression in HIV patients in an under-resourced setting. The study findings inform policy and influences decision relating to the care and management of such patients in Johannesburg South Africa, thereby improving health outcomes and reducing health inequalities in this group. This is because achieving and maintaining viral suppression in those that are socio-economically disadvantaged could reduce health care utilization and the cost of care relating to the treatment of comorbid infections in HIV patients.

Purpose of the Study

The purpose of this study was to describe the relationship between treatment of comorbidities (diabetes, cancer, or TB) and viral suppression among HIV-infected adults aged 18 – 49in Johannesburg. HIV infection is still highly prevalent in South Africa (StatsSA, 2017)despite government spending on HIV programs, which in 2017 was estimated to be more than $1.54 billion annually (Avert, 2020) and organizational and individual efforts to combat the disease. However, low rates of viral suppression have been implicated in high HIV prevalence in South Africa (UNAIDS, 2019).

Undoubtedly, South Africa has achieved the UNAIDS 2020 first 90% target of increasing awareness of HIV-positive status. The success of the ART program in South Africa has also increased the national life expectancy from 56 years in 2010 to 63 years in 2018 (Avert, 2020). However, the second target which is to achieve 90% initiation of antiretroviral therapy in HIV-positive individuals and the third target of achieving 90% viral suppression in PLHIV on treatment are still at 61% and 47% respectively (Lippman et al., 2019; UNAIDS, 2019).

The independent variable of the study was the treatment of comorbidities such as diabetes, cancer, or TB, and the dependent variable was viral suppression. Covariates included age, sex, race, and medical aid, currently on heart disease treatment, currently on hypertension treatment, currently on HIV treatment, retention to HIV care, adherence to treatment, disability, alcohol/drug abuse, highest educational qualification, marital status and employment status. The findings are positive contributors to social change by informing policy makers on existing gaps in the treatment of co-morbidities and viral suppression which may warrant the development of better strategies to achieve and maintain viral suppression (Kay et al., 2016).

Research Questions and Hypotheses

Research Question 1(RQ1): Is there a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg?

Null Hypothesis ($H_0 1$): There is no relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg.

Alternative Hypothesis ($H_a 1$): There is a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg.

Research Question 2 (RQ2): Is there a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg?

Null Hypothesis ($H_0 2$): There is no relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg.

Alternative Hypothesis ($H_a 2$): There is a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg.

Research Question 3 (RQ3): Is there a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49who has TB in Johannesburg?

Null Hypothesis ($H_0$3): There is no relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 who have TB in Johannesburg.

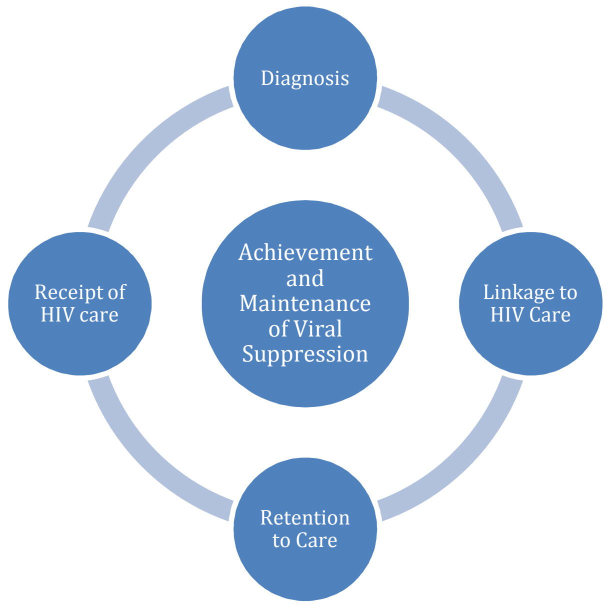
Alternative Hypothesis (H_a3): There is a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18-49 who have TB in Johannesburg.

Theoretical Framework

The HIV Care Continuum (HCC)initiative was formed through the Executive Order by the then U.S. President Barrack Obama following a passage in the Affordable Care Act (ACA) in HIV health care in the United States of America in 2013, which was done to prioritize the establishment of national indicators for HIV care (CDC, 2014). The HIV care continuum formed the framework for this research. The HCC is a public health model which consists of five steps such as (infection diagnosis, linkage to HIV care, receipt of HIV care, retention to care, achievement and maintenance of viral suppression) which people with HIV go through from diagnosis to achieving and maintaining viral load suppression (Kay et al., 2016).

Figure 1

HIV Care Continuum Process



The HCC was an appropriate framework for this research because this model is useful at the individual level as a tool to assess care outcomes, and at the population level, to analyze the proportion of community members with HIV who are in any of the successive steps. I used the HCC to answer research questions on the relationship between the treatment of comorbidities and viral load suppression of HIV infections in Johannesburg. This is because HIV-infected patients who were diagnosed with health conditions such as diabetes, cancer, or TB are most likely to be linked to care, retain in care, adhere to ART and achieve viral suppression (Kay et al., 2016).This framework is used by care providers and policymakers to identify areas of gaps in services and develop informed strategies to support patients to meet treatment outcomes (Kay et al., 2016).The findings of this study positively influence health care decisions relating to the health conditions and treatment of South Africans who need to co-treat other infections and HIV.

Nature of the Study

I used across-sectional quantitative research design to answer the research questions and this research method aligned with investigating the relationship or association between the treatment of comorbidities and viral load suppression among HIV-infected adults aged 18 –49 who were diabetic or have cancer or TB in Johannesburg.

This study involved secondary data analysis. I conducted descriptive statistics and binary logistic regression data analysis. Logistic regression assumes linearity of independent variables and log odds (Daniel & Cross, 2013; Laerd Statistics, 2013d). Although this analysis does not require that the dependent and independent variables be related linearly, it required that the independent variables be linearly related to the log odds (Daniel & Cross, 2013; Laerd Statistics, 2013d). Logistic regression analysis involved categorical and dichotomous outcomes, which means “No” =0 or “Yes” =1, (Laureate Education Producer, 2017d; Laureate Education Producer, 2017l; Laureate Education, 2017j; Warner, 2013). In this study, the independent variable was the treatment of comorbidities; with a focus on three predictive health conditions that included diabetes, cancer, or TB. The dependent variable was viral suppression.

Definitions

ART: ART is a combination of drugs taken by HIV-infected people to reduce the amount of HIV in the body (Centers for Disease Control and Prevention, 2019).

Cancer: Cancer is defined as a disease or growth that can start in almost any organ or tissue of the body when abnormal cells grow uncontrollably and go beyond their usual boundaries to invade adjoining parts of the body and/or spread to other organs (World Health Organization, 2020).

Diabetes: Diabetes is a chronic health condition or a metabolic disease that leads to elevated blood glucose levels. This condition over time leads to serious damage to the heart, blood vessels, eyes, kidneys, and nerves (World Health Organization, 2020).A diabetic condition is a situation whereby a person's body is either not able to produce enough insulin or cannot use the insulin produced effectively and efficiently or the body has become insulin resistant (World Health Organization, 2020).

HIV: HIV weakens an individual's immune system by destroying the CD4 cells, which help the body fight infection and disease. HIV replicates within the CD4 cell of an infected person and damages the cells (World Health Organization, 2020). "HIV is a type of virus called a retrovirus, and the combination of drugs used to treat it is called antiretroviral therapy (ART)" (CDC, 2020. 9). HIV has no cure but can be treated.

Tuberculosis (TB): TB is a disease caused by bacteria (Mycobacterium tuberculosis; World Health Organization, 2020). It is an airborne disease that mostly affects the lungs, kidney, spine, and brain. It spreads through the droplets of an infected person which could be as a result of coughing, spitting, sneezing and others. (Centers for Disease Control and Prevention, 2016; CDC, 2020).

Assumptions

In this study, I assumed that the data collected by the Human Sciences Research Council (HSRC) were accurate and relevant to this study. I also assumed that the test results of the patients were accurate and reliable. I assumed that data collected on viral suppression of patients by the HSRC are correct and relevant to this study. These assumptions were necessary for the context of this study because I relied on the secondary data provided by this HSRC for analysis of the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 in Johannesburg.

Scope and Delimitations

HIV prevalence in South Africa crosses across all ages, but this study focused only on adults aged between 18 and 49 who must co-treat diabetes, cancer, or TB (chronic diseases) with HIV in Johannesburg. This could limit the generalization of the results of this study. However, the ages of 18 – 49 represent the highest number of people infected with HIV in Johannesburg and South Africa as a whole (StatsSA, 2017).

Boundaries of the Study

The improvement in antiretroviral access and effectiveness has greatly increased the life span of people living with HIV infection; however, skyrocketing the number of aging HIV-infected population with more likelihood of experiencing comorbid conditions (Gimbel et al., 2020). This study was narrowed down to the relationship between treatment of comorbidities such as cancer, diabetes, or TB, as independent variables and viral load suppression (dependent variable).

Populations Included and Excluded in the Study

HIV infects and affects all ages, sexes, races and populations. However, this study only included all HIV-infected adults (males and females) aged between 18 and 49 who had cancer, diabetes, or TB in Johannesburg during the time of the study. I excluded HIV-positive patients who did not have cancer, diabetes or TB. It excluded HIV-infected persons under the age of 18 and those above 49 years of age.

Potential Contributions of the Study that Advance Practice and or Policy

The results of this study possibly inform public health professionals in areas to plan, enact and implement further policies and programs to improve viral load suppression of patients with treatment comorbidities which may reduce HIV prevalence and improve the health of South Africans. It may also contribute to other plans on how to co-manage treatment of other infections and HIV for the goal of achieving and maintaining viral suppression.

Potential Implications for Positive Social Change that are Consistent with and Bounded by the Scope of the Study

This research positively contributes to social change by helping policy makers identify existing gaps in co-treatment services, which may warrant the development of better strategies to help PLWHIV co-manage and achieve the treatment goal of viral suppression.

Limitations

HIV prevalence in South Africa crosses across all ages and provinces, but I focused only on adults aged between 18 – 49 who co-treated other (chronic diseases) health conditions such as diabetes, cancer, or TB with HIV, which could limit the generalization of the results of this study; however, the ages of 18 – 49 represented the highest number of people infected with HIV in South Africa (StatsSA, 2017), which is in line with findings of other researchers conducted in other countries of the world (UNAIDS., 2016-2021). This study was limited to only HIV patients with health conditions such as diabetes, cancer, or TB; whereas HIV-infected patients may have co-treated other health conditions other than the above mentioned three predictive health conditions, and that may have affected the generalization of the results. This study included all HIV-infected patients who were on the treatment of diabetes, cancer, or TB, without specifying the type of treatment or drug a patient was using for a specific health condition, which may have affected the internal and external validity (findings) of the study. This study included all men and women in the age bracket selected for this study, however, sex may be regarded as a confounder in this study, since studies show that women are most likely adherent to treatment than their male counterparts.

Significance

This study highlighted the effect of treatment of comorbidities on viral suppression in HIV patients in an under-resourced setting. In this study, I addressed the gap in the public health literature on the relationship between treatment of comorbidities and viral suppression in HIV patients in Johannesburg South Africa. The findings of this study positively influence health care decisions relating to the health conditions of South Africans who need to co-treat other infections and HIV. The study contributes to the body of knowledge in the field of public health on associations between the treatments of comorbidities such as diabetes, cancer, or TB and viral load suppression among HIV-infected adults aged 18 – 49.

This study highlighted the effect of frequent interaction with the health care system. It filled the gap in the public health literature on the relationship between treatment of comorbidities and viral suppression in Johannesburg South Africa. This study contributes to the body of knowledge in the field of public health on associations between the treatment of co -morbidities such as cancer, diabetes, or TB and viral load suppression among HIV-infected adults aged 18 – 49.

Potential Contributions of the Study that Advance Practice and or Policy

The results of this study possibly inform public health professionals in areas to plan, enact and implement further policies and programs that improve viral load suppression of patients with treatment comorbidities which reduces HIV prevalence and improves the health of South Africans. It also contributes to other plans on how to co-manage treatment of other infections and HIV for the ultimate goal of achieving and maintaining viral suppression.

Potential Implications for Positive Social Change that are Consistent with and Bounded by the Scope of the Study

This research positively influences health care decisions relating to the health conditions of South Africans who need to co-treat other infections and HIV. This study will make a positive social difference in the overall improvement of the health of people living with HIV and the entire South African communities.

Summary

In this chapter of the dissertation, I presented the research topic, problem statement, purpose of the study, and significance of the study, and meaningful background literature that informed the study. I also listed and defined the key terms, the research questions and hypotheses, the nature of the study, theoretical framework, and limitations of the study. I outlined the study variables and I described the types of data and methods of data collection and analysis that I used to conduct the study.

South Africa is the country most affected by HIV in the world, having the highest prevalence rate, with Johannesburg, which is a business hub, being the most populous city in the country. Viral suppression prevents HIV transmission, which reduces HIV prevalence; there are a high number of people who are living with HIV and comorbidities such as diabetes, cancer, and TB in Johannesburg. I proposed to discover if relationships existed between the treatment of co-morbidities and viral suppression among adult PLWHIV aged 18 – 49 in Johannesburg. The study findings positively contribute to social change by helping policy makers identify existing gaps in the treatment of co-morbidities and viral suppression, which warrants the development of better strategies in helping PLWHIV achieve the treatment goal of viral suppression. In the next chapter, I will review the literature on the study variables.

Chapter 2: Literature Review

Restatement of the Problem and the purpose

HIV has globally infected 37.9 million people, of which 23.3 million (62%) are on antiretroviral treatment. ART effectively suppresses viral load and viral transmission (Kay et al., 2016; UNAIDS, 2016). However, insufficient viral suppression (which means there is a detectable level of HIV in the blood of HIV-infected individuals) which is estimated to be around 47%is still a major problem in the HIV care continuum in South Africa (Center for Disease Control, 2019; UNAIDS, 2019). This has contributed to the high mortality and morbidity of people infected with HIV in South Africa (Ekeji, 2016; Galea et al., 2018; StatsSA, 2017), especially those co-treating other health conditions and HIV. The purpose of the study was to investigate whether relationships exist between treatments of co-morbidities such as diabetes, cancers, or TB and viral load suppression among HIV-infected adults aged 18 – 49in Johannesburg.

Synopsis of the Current Literature that Established the Relevance of the Problem

Antiretroviral treatment has immensely improved the quality of life, health and life expectancy of HIV-infected individuals (Center for Disease Control, 2019). However, Kay et al. (2016) argued that sustained viral load suppression is necessary to achieve optimal health outcomes. Kay et al. (2016) also stated that for the achievement of a free new HIV infection in communities, outcomes of every step of the HCC must be improved. Lazarus et al.(2016) pointed that an integrated health system with a people-centered approach is needed to ensure that virally suppressed individuals have a good health-related quality of life. South Africa is one of the countries in the world with the highest TB burden, which is associated with complications of treatment of comorbidities and management of TB and HIV (Myburgh et al., 2020). Kaposi Sarcoma, cervical cancer, and non-Hodgkin lymphoma, conjunctival cancer, vulva, and human papilloma virus are associated with HIV/AIDS (among PLWHIV) compared to HIV negative counterparts; and the linkage is largely based on co-infections with oncogenic viruses and poor access to HIV care (Dhokotera et al., 2019).

Preview of Major Sections of the Chapter

I reviewed the literature on the study's independent and dependent variables; shown in the synopsis of the current literature section of this chapter with a focus on the treatment of comorbid health conditions such as diabetes, cancer, or TB and viral suppression. In this chapter, I also discussed tuberculosis and HIV, cancer and HIV, diabetes and HIV, HIV care continuum, HIV and viral suppression in the city of Johannesburg and the theoretical framework of this study.

Literature Review Search Strategy

In this study, I also reviewed peer-reviewed articles, published books, and approved dissertations for scholarly literature needed for this research. I searched the key words such as *HIV treatment, Adherence to ART, HIV treatment and viral load suppression, viral load suppression in South Africa, Factors influencing HIV persistence, HIV prevalence, HIV treatment and quantitative studies, HIV in South Africa, Cancer treatment, and HIV, Diabetes treatment and HIV, HIV care continuum,* and *further studies*. Co-treatment and HIV, and factors influencing viral suppression in the entire search were from Walden Library, through health sciences databases: ProQuest Health and Medical collection, and ProQuest nursing and allied health sources, dissertations and I as well reviewed theses database, hence the review informed areas of gaps in the literature.

Theoretical Framework

Theories are definitions, concepts, and propositions that predict or explain situations and relationships between dependent and independent variables (Edberg, 2007; Jacobson, 2011; McLeroy et al., 1988; Walden University, n.d.). Theory helps in the evaluation and analysis of health behavior and health promotion interventions (Edberg, 2007; Jacobson, 2011; McLeroy et al., 1988; Walden University, n.d.).

HIV Care Continuum

HCC is a framework developed to achieve the optimal goal of viral suppression to an undetectable level in the blood of people living with HIV (Center for Disease Control, 2019). HCC is a framework that showcases the dynamic stages of HIV care (Kay et al., 2016). This framework is used to identify weak points in HIV care, interventions, strategies and policies to shape the continuum. The CDC (2019) also described five steps of HIV care continuum to include diagnosed (individual received a diagnosis of HIV), linked to care (HIV positive individual visited HIV health care provider within thirty days after HIV diagnosis), received care (HIV-infected person was given care), retained to care (PLWHIV was retained to care), and viral suppression (the amount or level of HIV in the blood of HIV-infected person is undetectable or very low).

Figure 2

Steps of HIV Care Continuum

Source: (Centers for Disease Control and Prevention, 2020).

Kay et al. (2016) noted that although the HIV care continuum is represented as a unidirectional, linear framework; HIV-infected individuals sometimes skip these steps, exit the continuum for some time and get back to an earlier stage. Kay et al. (2016) stated that the findings of the study conducted in the United States showed that the number of HIV-infected persons continually decreases at each successive step of the continuum. The five steps of the HIV care continuum are described as follows:

1. Diagnosis: This is the first step of the HIV care continuum, where the care providers offer patients the opportunity for HIV testing; HIV testing has become a

routine rather than risk-based practice in South Africa with patient's consent and confidentiality of result as the gold standard.

2. Linked to Care: This is the second step of the HIV care continuum; linked to care is described as a period that PLWHIV visited health care providers for HIV care within three months after been diagnosed with HIV (CDC, 2019).
3. Retention to Care: This third step is defined as the proportion of PLWHIV who have "two or more visits for routine HIV medical care in the preceding 12 months at least three months apart" (CDC, 2019, pg 5; Kay et al., 2019).Retention to care is popularly measured with two indicators which include: kept appointments for HIV medical care and missed appointments for HIV medical care. In Kay et al. (2019) studies showed that missed medical appointments are significantly associated with lower CD4 count and higher viral loads.
4. Adherence to Treatment: This is the fourth step in the continuum; and it can be defined as a primary determinant of viral suppression (Kay et al., 2019); there is no standard indicator for confirming that PLWHIVs consistently stay on ART medication (Kay et al., 2019). It is difficult to confirm the number of PLWHIV consistently adherent to ART (Kay et al., 2019).
5. Viral Suppression: Kay et al. (2019) defined viral suppression as the primary goal of HIV treatment and public health intervention; viral suppression is regarded as a current viral load of fewer than 200 copies per milliliter measured within the last 12 months.

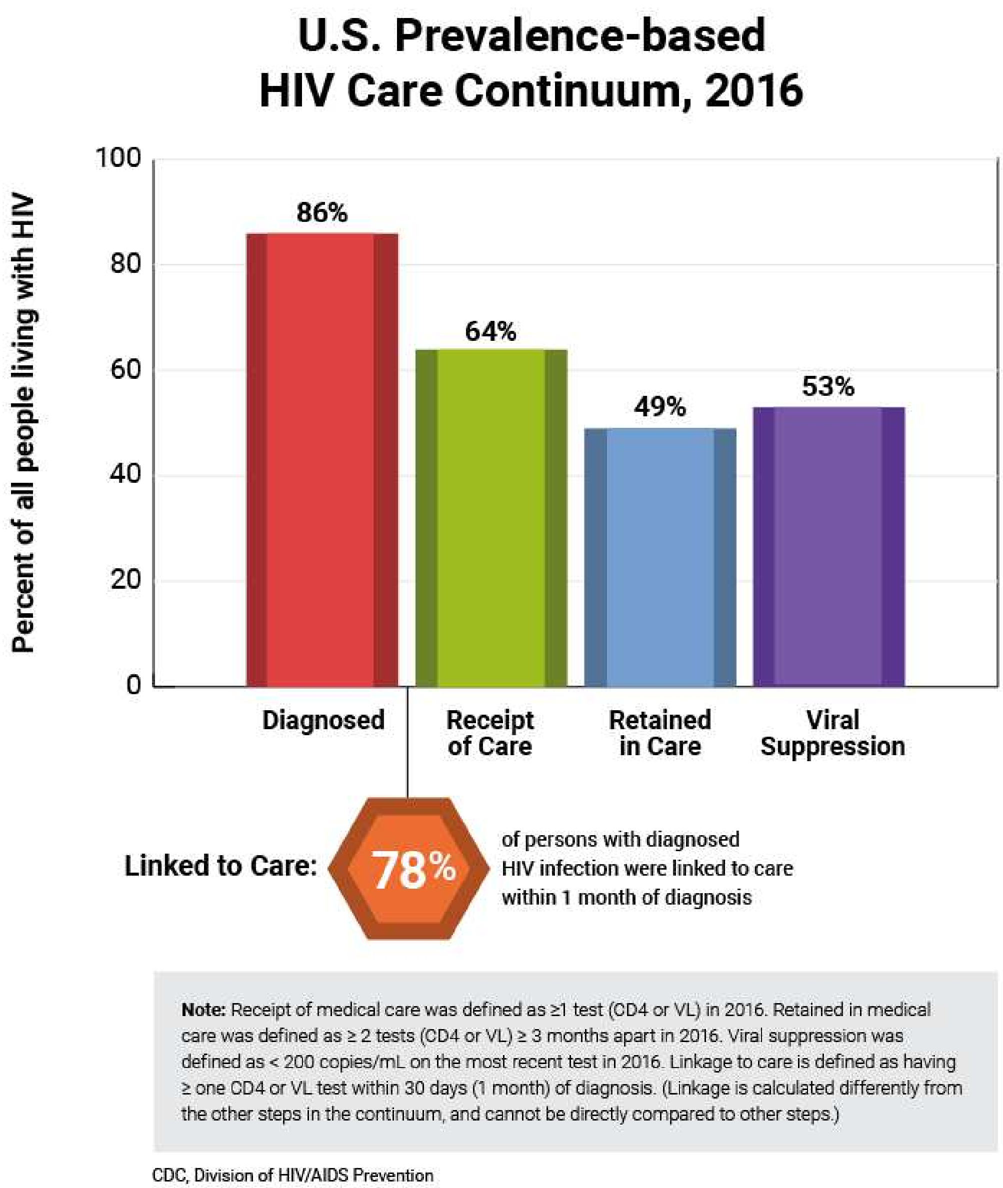
In 2013, the HIV care continuum initiative was created in the United States following presidential executive order that prioritized the establishment of a set of national HIV care indicators (Kay et al., 2016) this theory has gained visibility in the United States and has been applied to several public health research.

The HIV care continuum formed the framework of Kay et al.'s (2016) study, in which they reviewed HIV treatment cascades and care continuum: updates, goals, and recommendations for the future. It was also applied to examine domestic HIV care in the United States. CDC (2016) has applied the HIV care continuum in HIV care studies in the United States like the current study.

Figure 3 below is a visual display from the Centers for Disease Control and presentation showing U S HIV prevalence-based study results conducted using the HIV Care Continuum framework.

Figure 2

U.S. HIV Prevalence-Based Study Result Conducted Using HIV Care Continuum Framework.



I applied the HIV care continuum in this study following the rationale that this theory has important constraints that relate to the current study. The adults included in the current study must have been diagnosed with HIV, linked to care, received care, and at one stage tested for viral load suppression, although, many adults living with HIV are not virally suppressed. PLWHIV with comorbidities are most likely linked to care, they are on treatment (receive care) and viral load tests are conducted more often to monitor care progression (CDC, 2019). Similar studies conducted around the world have used HCC. I also used the HCC to investigate the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 and 49 with cancer, diabetes or TB in Johannesburg. The research question for this study was: Is there a relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18 – 49 who had cancer, diabetes, or TB in Johannesburg? This question was related to building the theory HCC which believes that linkage to care and retention in care is key to achieving optimal health outcomes (Kay et al., 2016).

Comorbid Treatment

Comorbid treatment can be described as the treatment of more than one medical condition for a patient (Chang et al., 2019); examples of this include being on ART and chemotherapy, or being on ART and diabetic treatment, or being on ART and TB treatment. Comorbid treatment is associated with poorer clinical outcomes, increased use of health facilities, and high cost of health services such as hospitalization; these deteriorating health conditions are common with an aging population. Islam et al. (2017) concluded that viremia in people living with HIV is independently associated with the impaired diffusing capacity for carbon monoxide; hence, viral load suppression has been proven to allow recovery in diffusing capacity over time. This is important to this study since the focus is on the treatment of comorbidities and viral suppression. Crawford and Thornton (2019) identified that substance use is related to multimorbidity of chronic conditions such as diabetes, and unsuppressed viral load among people living with HIV. However, an integrated health system with a people-centered approach ensures that people live longer with multiple co-morbidities (Lazarus et al., 2016). It is important to ensure that virally suppressed individuals have a good health-related quality of life (Lazarus et al., 2016); because HIV can resurge in a previously virally suppressed patient if treatment adherence is lost thereby exposing the patient to other opportunistic infections and comorbidities.

Tuberculosis and HIV

In a study by Ayah (2018), tuberculosis was one of the most common comorbidities associated with a high level of loss to follow-up and early mortality among people living with HIV/AIDS. Myburgh et al. (2020) pointed out that South Africa is one of the countries in the world with the highest burden, with 78,000 related deaths of complications of comorbid treatment and management of TB and HIV in 2017. Ernesha et al. (2016) reported that non-adherence to concurrent treatment was more likely to be among patients with extra pulmonary TB and undisclosed HIV status. In the study of Ernesha et al.(2016) patients co-infected with TB and HIV were more likely to adhere to TB treatment compared to antiretroviral treatment.

In South Africa, treatment of co-morbidities such as TB and HIV has been part of government health policies. It is a government policy to test every TB new patient for HIV in Gauteng Province (Gauteng Department of Health, 2020; South Africa National AIDS Council, 2017), However, literature on the association between treatment of co-morbidities such as TB and viral suppression among adults aged 15-49 in Johannesburg is limited; hence this study has filled that gap.

In 2007, a study conducted revealed that an estimated one-third of HIV-infected individuals would likely develop TB in the long run. The department of health of Gauteng (2020) reported that TB is responsible for every one out of three HIV-related deaths. Despite routine TB and HIV screening and testing on all patients with presumptive and diagnosed tuberculosis at health facilities; preventive TB therapy is provided to all HIV-infected persons without active TB (Gauteng Department of Health, 2020). People who are infected with HIV are 20 to 30 times more likely to develop active TB. In 2013, 1.5 million people globally died of TB infection (Dimitriads, 2015).

Cancer and HIV

In Dhokotera et al.(2019), it was stated that Kaposi Sarcoma, cervical cancer and non-Hodgkin lymphoma, conjunctival cancer, vulva, and human papilloma virus are associated with HIV/AIDS (among PLWHIV) compared to HIV negative counterparts; and the linkage is largely on the bases of co-infections with oncogenic viruses and poor access to HIV care. Conversely, Dhokotera et al. (2019) also pointed that people living with HIV are at low risk of cancers such as breast, prostate, and colon, inferring that not all types of cancer are related to immune suppression.

Diabetes and HIV

Chang et al. (2019) emphasized that patients with HIV received poorer care for their coexisting conditions than did those without HIV in the United States of America. HIV-infected individuals with cardiometabolic conditions were less likely to progress in the stages of care compared to patients without co-infection. Chang et al. (2019) explained that Diabetes was not associated with progression in care, unlike, patients with hypertension comorbidity that had greater progression in care. According to Bosire et al. (2018) HIV-infected individuals with diabetes condition in Kenya were treated for HIV than diabetes; due to the availability of AIDS funding, and the policy of out-of-pocket payment for diabetes and this practice has severely affected comorbid treatment outcomes.

Diabetes has been described as a chronic disease that manifests when the body of an individual cannot effectively use the insulin it produces (Kay et al., 2019). Kay et al. (2019) defined diabetes as a fasting blood glucose level of greater than 126mg meaning eight hours without food before blood specimen was collected for testing; a blood glucose level of 200mg after eating or self-reported ongoing diabetes treatment. In this study, patients' diabetes, cancer, and TB status were ascertained from the treatment records.

Viral Suppression

The CDC (2019) revealed that sustained viral suppression effectively prevents transmission of HIV from an infected person to uninfected individuals. Kay et al (2016) also reported that out of eighty-six percent of people diagnosed with HIV infection, only approximately thirty percent achieved viral suppression in the United States in 2016. Similarly, of the ninety percent of people who know their HIV-positive status in South Africa, only forty-seven percent had achieved viral suppression in 2019 (UNAIDS, 2019). In Kay et al (2019), Gardner and colleagues suggested that an improvement in just one step of the continuum would make a little difference in the ultimate goal of achieving viral suppression. Importantly, people living with HIV who were diagnosed, linked to care, retained in care, and adhered to treatment had the highest rate of achieving viral suppression (Cabral et al., 2018; Gómez-Olivé et al., 2013; Dorrington&Moolla, 2017). Yet, Lazarus et al. (2016) argued that achievement of viral suppression is not the end of the fight against HIV, because virally suppressed PLWHIV still need good health-related quality of life.

Covariates of This Study and the Outcome

In a study by Geter et al. (2019), black women at the median age of 46 years were less likely to achieve viral suppression and more likely to fail to adhere to ART compared to Hispanic, Latinas and white women respectively. Geter et al. (2019) also reported that factors associated with non-achievement of viral suppression include the use of public insurance as compared to the use of private insurance, receiving care from the public clinic as compared to care from a private clinic and non-adherence to ART. The findings of Marinda et al. (2020) show that women have higher percentages across all three UNAIDs 2020 target indicators which include awareness of HIV status, being on ART and achievement of viral suppression compare to men. Linkage to care and retention to ART are areas of deficiencies that affect the achievement of viral suppression in South

Africa (Marinda et al., 2020). Rangarajan et al. (2016) also reported that the rate of viral suppression in males is higher compare to that of females within the same time of being on ART.). However, Rangarajan et al. (2016) further reported that no significant association exists between wealth index, sex, educational level, marital status, residential location, and viral suppression. Lokpo et al. (2020) also found that sex does not have a significant relationship with viral suppression.

The study of Imaz et al. (2018) which explored 'cerebrospinal fluid drug concentrations and viral suppression in HIV-infected patients receiving ritonavir-boosted atazanavir plus lamivudine dual antiretroviral therapy' found that "12 weeks after switching to ATV/r plus 3TC, CSF HIV-1 RNA was maintained at less than 40 copies in most patients. However, CSFATV C24h was close to or within the IC50 range in most of the population. Ali &Yirtaw (2019) found that people on ART can achieve plasma viral suppression within an estimated average time of 181 days. The time of achieving viral suppression differs according to age.

In the study of Ali&Yirtaw (2019), patients within the age bracket of 30 and 39 years were found to achieve viral suppression within 92 days of antiretroviral treatment compared to 181 days of ART required of patients between the ages of 50 and 59. Whereas, Bahemana et al. (2020) reported that no significant differences in viral suppression exist between age brackets. These are conflicting ideas that this study may clarify through descriptive analysis of these confounding variables. Adherence to ART and being regularly on treatment for more than three years is significantly associated with viral suppression (Lokpo et al., 2020) Marital status and CD4 baseline were reported to be significantly associated with viral suppression (Ali &Yirtaw, 2019).

Socioeconomic Status

The study of Wohl et al. (2017) found that homeless persons in the United States of America metropolitan are less likely to achieve viral suppression compare to persons with better socio-economic status. Income inequality is one of the factors associated with viral suppression in females (Kalichman et al., 2019). Socioeconomic disadvantages identified as unstable housing, lack of University education, unemployment and financial hardship are significantly associated with non-adherent to ART and non-virologic suppression (Burch et al., 2016). In a study conducted by Ssekalembe et al.(2020) low body weight and a longer period between diagnosis of HIV positive status and the real-time of starting ART is strongly related to non-viral suppression. Body gaining behavior and early initiation to treatment immediately after confirmation of the diagnosis is highly recommended (Ssekalembe et al., 2020). Adherence to ART influences weight gain and viral suppression (Khan et al., 2019), hence weight gain is correlated with the time or period one has been on treatment. However, weight gain must be closely monitored against obesity.

HIV and Viral Suppression in the City of Johannesburg

The City of Johannesburg is one of the Metropolitan Municipalities in the Gauteng province of South Africa. Johannesburg is one of Africa's most advanced commercial cities, with an estimated population of about five million people, which is made up of both local and international migrants. The city of Johannesburg accounts for

36% of Gauteng's population and eight percent of South Africa's population (Gauteng Department of Health, 2020). However, in 2019, 13.05% of people living in Gauteng were HIV positive; and Gauteng had the second-lowest viral load suppression (47.27%) among provinces in South Africa. Based on the demographic data of 2016 in the city of Johannesburg, people aged between 15-and 64-years-old accounted for 68.9% of the population. And the population with the highest HIV prevalence was found to be between the ages of 15 and49 (UNAIDs, 2019). Research has shown that middle age groups are as well prone to chronic diseases such as cancer and diabetes; while HIV itself is associated with TB (UNAIDs, 2019). However, no research has been conducted on the relationship between the treatment of co-morbidities and viral suppression of HIV infection in Johannesburg. Hence, this study will fill that gap.

Summary

In this chapter, I reviewed the literature on the key study variables; as well as the HCC which formed the backbone of this investigation. I also reviewed the literature on few confounding variables such as age, sex, adherence to ART, and viral suppression. Viral suppression is still low, despite the evidence that HIV testing, enrollment to treatment, retention to care, and treatment adherence have shown tremendous improvements.

Non-adherence to treatment, interruption of treatment, and loss to follow-up of patients enrolled for treatment have contributed to high mortality and morbidity of people infected with HIV in South Africa (Dorrington, & Moolla, 2017). HIV sustains long-lived reservoirs in the blood of the infected persons, which rapidly resurges if treatment is discontinued no matter the magnitude of suppression achieved with anti-retro viral treatment (Stevenson, 2017). However, this research highlights the effect of the treatment of comorbidities on viral suppression in HIV patients in an under-resourced setting. It addresses the gap in the public health literature on the relationship between treatment of comorbidities and viral suppression in HIV patients in Johannesburg South Africa.

Chapter 3: Research Method

Introduction

The purpose of this study was to investigate the relationship between treatments of comorbidities and viral load suppression among HIV-infected adults aged 18 – 49 who had diabetes, cancers, or TB in Johannesburg. In this chapter, I presented the research questions and hypotheses. I also presented the research design and rationale for the study, as well as the study population. This chapter included a description of the secondary data set used, the format for data analysis, and a summary of the chapter.

Study Variables

The independent variable that I used for this research is the treatment of co-morbidities, which I referred to as the conceptual definition of the study independent variable. Thus, I focused the operationalization of the independent variable on the PLWHIV currently being on treatment for diabetes, cancer or TB (diabetes treatment, cancer treatment, TB treatment), which I measured as Yes/ No. The valid values included yes (1) and no (0). I defined cancer treatment as one currently taking cancer medication. I also defined diabetes treatment as currently taking diabetes medication and TB treatment as currently taking TB medication. These are dichotomous variables In this study, being on treatment for health conditions such as diabetes, cancer, or TB was the major focus of predicting variables. . I described the confounding variables such, age, sex, race, linkage to care, retention to care, adherence to ART, marital status, currently being on hypertension treatment, currently being on heart disease treatment, alcohol use, disability, highest education qualification, medical aid, and employment status in the study analysis.

Hence, these covariates may or may not have influenced viral suppression of the PLWHIV.

The conceptual definition of this study's dependent variable was viral load suppression. Hence, I operationalized the dependent variable as the VL test result, whereby I defined viral suppression as less than 200 copies /ml on the most recent VL test in the dataset. This implies that a VL test result with more than 200 copies /ml on the most recent patient's test in the dataset is not considered virally suppressed. The dependent variable for this study was a categorical, precisely nominal variable. In the dataset, viral suppression was responded as unsuppressed =0 and suppressed =1.In research studies, combinations of different types of variables are possible (Osborne, 2015; Warner, 2013); however, in this study the dependent and independent variables were dichotomous.

In this study, I applied across-sectional quantitative research approach. The cross-sectional research design is defined as a snapshot of a particular group of people at a given point in time (Babbie, 2007; Creswell, 2009; Setia, 2016). The cross-sectional research design was feasible and aligned with investigating the relationship between treatment of comorbidities and viral load suppression among HIV-infected adults aged 18 – 49 who were diabetic had cancer or TB in Johannesburg. This is because of key characteristics of cross-sectional design, which include the opportunity to investigate numerous variables at once (for example, cancer, diabetes or TB and viral suppression), the benefit of applying a cross-sectional quantitative research design in this study is that it offered me the opportunity to investigate the population's current prevailing situation such as treatment of comorbidities and viral suppression at a single point in time. I used across-sectional study approach to determine whether exposure to specific risk factors such as treatment of diabetes, cancer, or TB might correlate with viral suppression outcomes. However, it cannot demonstrate cause and effect (Babbie, 2007; Creswell, 2009; Setia, 2016).

The fact that cross-sectional research design saves time and is less expensive makes it attractive (Setia, 2016). I used secondary data sets in conducting the study. Secondary data is defined as data that had been previously gathered for a purpose other than for the current research, which can be accessed and analyzed by researchers (Creswell, *&* Creswell**,** 2018). Secondary data is existing data. It is used to facilitate the research, in terms of studying large samples, and saves time and money. The terms and conditions of the Human Sciences Research Council (HSRC) for granting me access to the dataset included that data and documentation should not be duplicated sold or redistributed without HSRC's approval. The dataset must only be used for research or educational purposes. HSRC stipulated that after use, the data file must be destroyed. High confidentiality measures must be observed to preserve the organization and the individuals, and no attempt should be made to identify the individuals and the organizations in the dataset. The HSRC stated that the organization 'HSRC' will be acknowledged in all published and unpublished works based on the data using the provided citation. The organization 'HSRC' further stated that the HSRC will be informed of any books, articles, conference papers, theses, dissertations, reports, or other publications resulting from work based in whole or in part on the data and documentation. It was further stated that for archiving and bibliographic purposes an electronic copy of all reports and publications based on the requested dataset will be sent to the HSRC. Finally, it was pointed out that my failure to comply with the End User License may result in sanctions being imposed on me (Human Sciences Research Council, 2017).

Methodology

Study Population

The study population included HIV-positive adults aged between 18 and 49 who had cancer, diabetes, or TB in the city of Johannesburg. This is defined as adult men and women within the age bracket of 18 and 49, who were co-treating health conditions such as cancer, or diabetes, or TB and HIV in Johannesburg Gauteng Province. I considered this population very important for this study because there was a gap in the literature on this topic in this population. Importantly, this age group had the highest HIV prevalence in the chosen population, with Gauteng (Johannesburg) being second to last virally suppressed province in South Africa (Dorrington et al., 2017).

Sampling Method

In Ellis, 2020, Murad et al. (2018) argued that it does not make any practical or economic sense to study a whole population; rather, it is economically suitable to study a sample of a population. Cluster sampling is defined as a method of surveying a population based on naturally occurring groups of that population. The statistical sampling method is used for a non-homogenous population to allow random sampling (Creswell & Creswell, 2018; VukojevićBorislav, 2016). The cluster sampling method requires the classification of the study population into groups (clusters), then randomly selected samples (clusters) for the study to represent the population (Falahi et al., 2016; Quatember, 2019). This sampling method saves time and cost; however, it is prone to sampling error and the study findings may not be a true representation of the study population (Ellis, 2020).

In this study, I analyzed an existing patient's de-identifiable electronic records from the HSRC household and national level in the2017 survey. This was the fifth household national level repeat survey of the human sciences research council of 2017 which included every member of the household. There were 15000 targeted visiting points (VPs), with 82% percent household responses in the survey (Human Sciences Research Council, 2017). Among the eligible individuals, 61.1% provided a blood sample for HIV testing, which was confidentially linked to the completed questionnaire (Human Sciences Research Council, 2017). The survey was purposed to monitor the progress in reaching the UNAIDS 90-90-90 target for HIV eradication and to estimate HIV prevalence in South Africa. It was also meant to estimate the level of exposure to antiretroviral therapy and HIV drug resistance in the different provinces and districts of South Africa (Human Sciences Research Council, 2017).

According to the HSRC (2017), the survey was purposed to determine the viral load (VL) in HIV-positive individuals and to estimate the proportion of persons receiving antiretroviral therapy who were virally suppressed. The survey was meant to assess the relationship between social and behavioral factors and HIV, as well as the prevalence of self-reported TB, related knowledge and attitudes (HSRC, 2017). The data collection was done longitudinally from 2016 – 2018. Data were collected through clinical measurements, face-to-face interviews, and focus group observation from the South African population, excluding individuals living in educational institutions, old-age homes, hospitals, homeless people, and uniformed-service barracks (HSRC, 2017). Digital electronic tablets were used for questionnaires, and dried blood spot (DBS) samples were used to collect blood samples for biomarker testing.

According to the Human Sciences Research Council (2017), a multistage disproportionate and stratified cluster sampling approach was used in this household survey, with small area layers (SALs) as the primary sampling unit (PSU). A new HSRC master sample was developed through the disproportionate stratified sampling of 1 000 SALs from the newly released National Sampling Frame of 84,907 SALs from Statistics South Africa release 2011 (HSRC, 2017). The SALs were sampled with a probability proportional to their size with the number of VPs as a measure of size (MOS). The released SALs were updated in 2015 and mapped using aerial photography to create a new master sample, which was used as a basis for sampling households in this 2017 survey (HSRC, 2017).

The primary sampling unit was 1,000 SALs, and allocation of the samples was done by allocating SALs disproportionately to province, race group, and geographic type (geotype or locality type). There were nine strata for province, three strata for locality type, reporting domain were locality type n=3, age group n=4, sex n=2 and race n=4. Based on the selected 1,000 SALs, 15 VPs were systematically sampled, since the selection of the SALs was stratified by province and locality type (HSRC, 2017).

According to the Human Sciences Research Council (2017), three locality types were identified: urban, rural informal (tribal area), and rural formal (farms) and the race category were used as a third stratification variable in the urban localities.

The survey over-sampled areas that were dominated by Indian, colored or white race groups as well as the sparsely populated Northern Cape, to ensure that the minimum required sample sizes were obtained for the three minority race groups in South Africa and Northern Cape (Human Sciences Research Council, 2017). VPs and households were used as secondary sampling units (SSUs). Within each household, all consenting members formed the ultimate sampling unit (USU) (Human Sciences Research Council, 2017).

The survey was funded by Bill and Melinda Gates Foundation, Centers for Disease Control and Prevention, Human Sciences Research Council, President's Emergency Plan for AIDS Relief (Emergency Plan), South African National AIDS Council, and United Nations Children's Fund (Human Sciences Research Council, 2017).

I got permission for data access and downloaded the dataset as directed, respecting and observing all confidential, ethical rules and protocols to maintain confidentiality throughout the study. I focused on the variables of interest such as patient's HIV positive status, being currently on cancer medication or treatment, being currently on diabetes medication or treatment, and being currently on TB medication or treatment, and patient's viral suppression. (VL test result indicating less than 200 copies /ml on the most recent test in 2020 (virally suppressed) or the VL test result indicating more than 200 copies /ml on the most recent test in 2020) (virally unsuppressed) as located in the database provided by the HSRC. I did not recruit study participants, thus secondary data related to the study was used for analysis. I contacted the HSRC for the secondary dataset needed for the study, and permission, and access to the dataset was granted to me for this study by HSRC.

Research Questions and Hypotheses

I developed the following research questions and hypotheses based on the study problem statement, study purpose and the study background statement:

1. Is there a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg?

Null Hypothesis ($H_0 1$): There is no relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg.

Alternative Hypothesis ($H_a 1$): There is a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 with diabetes in Johannesburg.

2. Is there a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg?

Null Hypothesis ($H_0 1$): There is no relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg.

Alternative Hypothesis (H_a1): There is a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 who have cancer in Johannesburg.

3. Is there a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49who have TB in Johannesburg?

Null Hypothesis (H_01): There is no relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 who have TB in Johannesburg.

Alternative Hypothesis (H_a1): There is a relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18-49 who have TB in Johannesburg.

Data Analysis Method Plan

The data analysis planned included descriptive analysis and logistic regressions. In this study, I interpreted the Odds ratio (OR) in the three major independent variables from logistic regression (diabetes, cancer, and TB).I further used the frequencies and percentages as the measure of central tendency to analyze the three major independent variables before logistic regression since these variables are categorical data. Logistic regression allows for statistical analysis of multiple predictor variables with the dichotomous outcome (Warner, 2013). This test was suitable for this research because it includes multiple dichotomous variables, such as being treated for diabetes yes (1) or not treated for diabetes no (0); being treated for cancer yes (1) or not being treated for cancer no (0); being treated for TB yes (1) or not being treated for TB no (0); virally suppressed Yes (1) or virally not suppressed (0).

I defined the operationalization of the independent variables as being treated or not being treated for diabetes, cancer, or TB which would be yes /no (1/0) respectively. “Yes” standing for being treated, and “no” standing for not being treated. These are dichotomous variables (Laureate Education, 2017j; Osborne, 2015; Warner, 2013; Warner, 2013). I planned that the operationalization of the dependent variable would be VL less than 200 copies /ml on the most recent test in 2017 to be virally suppressed (1) or not virally suppressed (0) when the VL is more than 200 copies /ml on the most recent test in 2017. I utilized the odds ratio as a measure of association.

Logistic regression assumes that the observations are independent; however, this assumption was handled by careful sampling (Warner, 2013). Another assumption of the logistic regression is that the natural log of the odds ratio and the measurement variables have a linear relationship, although it is difficult to observe when this assumption is violated (Frankfort-Nachmias et al., 2018), however, I have handled this using data transformation. In this study, I utilized logistic regression of the statistical package for the social science (SPSS) software version 25.0 to analyze the research questions and hypotheses.

Logistic regression helps in minimizing error, as well as provides a better explanation of the complex social world (Ekeji, 2018; Frankfort-Nachmias et al., 2018). The independent variables were dichotomous.

In this research, I measured the independent variables as follows:

Cancer: being treated (yes =1) or not being treated (No =0)

Diabetes: being treated (yes =1) or not being treated (No =0)

TB: being treated (yes =1) or not being treated (No =0)

Positivity or negativity may have been determined by the patient's testimony, been on treatment, test results or medical examinations.

I planned to measure the dependent variable as viral suppression

VL< 200 copies /ml on the most recent test in 2020 (virally suppressed =1) or

VL > 200 copies /ml on most recent test in 2020 (not virally suppressed =0).

Logistic regression analysis involved categorical and dichotomous outcomes, which means Yes =1 or No =0 (Laureate Education Producer, 2017d; Laureate Education Producer, 2017l;Laureate Education, 2017j; Warner, 2013).Logistic regression assumes linearity of independent variables and log odds. Although the analysis did not require the dependent and independent variables to be related linearly, it required that the independent variables are linearly related to the log-odds (Frankfort-Nachmias et al., 2018; Laureate Education, 2016j; Tawfik, 2020).

- In this study, I maintained the best logistic regression practices as below:

  Each key independent variable such as diabetes, cancer, and TB was run independently in a binary logistic model (basic model) with the dependent variable (viral suppression). Specifically, each research question was run in a binary logistic model.

- I also conducted the final logistic model analysis involving each of the three (diabetes or cancer, or TB) independent variables at a time adjusting with the variable; medical bills paid by medical aids.

According to Jager et al (2007), confounding variables obscure the "real" effect of an exposure on the outcome variable. Researchers are expected to prevent or control confounding, and this process creates errors in most cases. However, the rule for including a potential confounder in the final logistic regression model includes that the variable must satisfy the following three criteria: (1) the confounding factor must be associated with both the risk factor of interest and the outcome. (2) It must be distributed unequally among the groups being compared and (3) it must not be part of the causal pathway (Jager et al, 2007). The variable has to be statistically significant in the basic model for it to be included in the final model. I observed the above mentioned rule in the analysis of this study. According to Jager et al (2007),a stronger association or effect of a variable on an outcome than existed is referred to as positive confounding, and the opposite is negative confounding which is a situation where a confounding variable masks an association or effect that existed. The fact that it has been empirically proven that HIV treatment (antiretroviral treatment) leads to viral suppression (Kay, et al, 2016; Khan et al., 2019; Lokpo et al., 2020), and reduces viral load (Centers for Disease Control and Prevention, 2014; UNAIDS, 2016), currently taking HIV medication was not included in the final logistic regression model to adjust the odds ratio because it is in the causal pathway in this study.

Threats to Validity

Validity refers to the extent to which a measurement process truly measures the variable that it claims to measure (Aschengrau et al., 2008; Warner, 2012). This study was designed to use secondary data of patients collected for a purpose different from this research. The test results of patients on cancer, diabetes or TB confirm their status, and being on treatment or care for the health condition was another way of validating or confirming PLWHIV having cancer, diabetes or TB. The patient's VL test results were recorded by the health care provider, which is assumed to be accurate. On the other hand, there might be reactive errors (which can occur as a result of malfunction, or incorrect material used for the test, for example, inaccurate litmus paper or reagent) in the results and even typographical errors (for example, typing 0 when supposed to type 1) while entering the results in the systems, which can affect the validity of the result.

It was stated earlier that HIV infection cuts across all ages, races and populations, but in this study, I focused only on the HIV-infected adults aged between 18 and 49 who co-treat cancer, diabetes, or TB in Johannesburg, which can be seen as an internal validity threat. However, this age bracket is the most HIV-infected worldwide (Dorrington et al, 2017; World Health Organization, 2019). The secondary data usage has ensured studying a very large sample of this population.

Ethical Considerations

Ethical consideration is a very important aspect of research. In every research method be it quantitative, qualitative, and mixed-method, some level of ethical issues must be addressed (Bryman &Bell, 2007). Although, the magnitude of ethical issues in different methods are not the same, especially when the researcher has to collect primary data on sensitive issues from respondents; ethical considerations are more than when a researcher is set to analyze existing data (secondary data). In this study, an application and approval to conduct the study were required from the Walden University Institutional Review Board (IRB). Approval and permission were also granted for access to a de-identifiable dataset from the HSRC South Africa for this study. Generally, research participants are entitled to be informed of the study purpose, methods, benefits, potential risks, discomforts, issues relating to the right to refuse or withdraw from participation at any time in the study, and issues of confidentiality involved in the study (Bryman & Bell, 2007; Saunders et al, 2012; World Medical Association, 2008).

According to World Medical Association (2008), the following ethical principles are key considerations to conducting research (dissertation).

- Ensuring protection of the privacy of study participants.
- Ensuring the confidentiality of the study data.
- Obtain consent from the study participants
- Ensure that study participants are not subjected to any harm.
- Respect the study participants.
- Ensure anonymity of participating individuals and organizations.
- Avoidance of any form of exaggeration about the aims and objectives of the study.
- Declaration of any possible conflict of interest to the study.

- Ensure honesty and transparency in every engagement, communication, and collaboration concerning the study.
- It is of paramount importance that written consent is secured before the commencement of data collection. Practically, this means that sufficient information and assurances are provided to study participants; to enable them to understand the implications of participating in the study, which can help them to make an informed, free decision about whether or not to participate, without any pressure or coercion (Bryman et al, 2007; Saunders et al., 2012).

In this study, a secondary dataset (existing data) was used. Dataset was obtained from the Human Sciences research council South Africa following permission to do so. The dataset was downloaded and saved in a computer protected with avast anti-virus. The dataset was protected from being available to other users or the internet and was destroyed at the end of the study. The following measures were taken to protect human privacy in this study:

- The IRB application was submitted to Walden University and approval was received.
- There was no contact with the study participants; hence the dataset used was de-identified.
- The password provided by the organization to the researcher for access to the dataset has remained secret.

- There was no concern of deception, or coercing human participants, hence the study was designed with secondary data analysis of unidentifiable data.
- I ensured that no amendment was made to the downloaded dataset, to protect participants' information.
- The dataset was only used for data analysis.
- I commenced data analysis after receiving approval from IRB of the ethical review application. And all other ethical issues and protocols related to this study were considered (Bryman et al., 2007; Saunders et al., 2012; World Medical Association, 2008).

Summary

The purpose of this study was to investigate the relationship between treatment of co-morbidities and viral load suppression among HIV-infected adults aged 18 – 49 who were diabetic, had cancers, or TB in Johannesburg. Hence, I discussed the research design, study population, sampling method, the secondary dataset used, research questions and hypotheses in this chapter, as well as the data analysis plan and ethical considerations. I also presented the visual display of the statistical findings (results) of the study in chapter four.

Chapter 4: Results

Presentation of Study Results

In this chapter, I conducted logistic regression analysis using SPSS version 25.0, and the analysis and results were based on the three research questions. The number of participants included in the analysis to answer the RQ1was565, RQ2was 526, and RQ3 was 602. There was some recoding of variable values; for instance, the value 1= yes remained as it was in the original dataset, but 2 = no was recorded as 0 = no. This was done to be able to conduct the analysis using SPSS and the fact that viral suppression which was the dependent variable was originally corded with values 0 = unsuppressed and 1 = suppressed.

In this study, I utilized a secondary dataset to answer the three research questions which included whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 with diabetes in Johannesburg. To determine if a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 with cancer in Johannesburg. To determine whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 with TB in Johannesburg. I conducted this study to make a positive social change through the findings. The study highlighted the effects of the treatment of comorbidities on viral suppression in HIV patients in a setting with limited resources.

Table 1 presents the frequency and percentage of the study dependent variable, as well as the frequencies and percentages of the independent variables of the study. Table 2 presents the frequencies and percentages of the study demographic covariate variables, descriptive statistics of covariate variables on care received are presented in Table 3. Table 4 presents frequencies and percentages of the socio-economic covariate variables of the study. The results of the study basic regression model for the covariates were presented in tables 5 and 6, these tables show a summary of the logistic regression analysis of the study variables that were statistically significant at (one variable and outcome analysis), the study independent variables, significant covariates, and the dependent variable that answered the three research questions and hypotheses were presented in tables 7 – 12.

Table 1

Descriptive Statistics Showing Frequencies, Percentages, and Viral Suppression of the Study Dependent and Independent Variables

Study variables	Frequency	Valid Percent	Viral Suppression	
			Unsuppressed	Suppressed
Viral load suppression				
	210	34.9	210 (34.9%)	392 (65.1%)
	392	65.1		
Total	602	100.0		
Currently on Diabetes treatment				
No	133	23.5	46(23.7%)	87 (23.4%)
Yes	432	76.5	148(76.3%)	284 (76.5%)
Total	565	100.0	194	371
System Missing	37			
Total	602			
Currently on Cancer treatment				
No				
Yes	174	33.1	66 (36.3%)	108 (31.4%)
Total	352	66.9	116 (63.7%)	236 (68.6%)
System Missing	526	100.0	182	344
Total	76			
	602			
Currently on TB treatment				
No	414	68.8	157 (74.8)	257 (65.6%)
Yes	188	31.2	53 (25.2%)	135 (34.4%)
Total	602	100.0	210	392

Table 2

Descriptive Statistics Showing Frequencies, Percentages, and Viral Suppression of the Study Demographic (Covariates) Variables

Study variables	Frequency	Valid Percent	Viral Suppression	
			Unsuppressed	Suppressed
Sex				
Male	179	29.7	71 (33.8%)	108 (27.6%)
Female	423	70.3	139 (66.2%)	284 972.4%)
Total	602	100.0	210	392
Race				
African	357	59.3	124 (59%)	233 (59%)
Coloured	235	39.0	82 (39%)	153 (39%)
Indian	2	.3	1 (0.5%)	1 (0.3%)
White	8	1.3	3 (1.4%)	5 (1.3%)
Total	602	100.0	210	392
Marital status				
Married	184	30.6	67 (31.9%)	117 (29.8%)
Never Married	332	55.1	119 (56.7%)	213 (54.3%)
Divorced/Separated	23	3.8	7 (3.3%)	16 (4.1%)
Widower/Widow	63	10.5	17 (8.1%)	46 (11.7%)
Total	602	100.0	210	392
Disability				
No	576	95.7	199 (94.8%)	377 (96.2%)
Yes	26	4.3	11 (5.2%)	15 (3.8%)
Total	602	100.0	210	392

Table 3

Descriptive Statistics Showing Frequencies, Percentages, and Viral Suppression of the Study Covariate Variables on Care Received

Study variables	Frequency	Valid Percent	Viral Suppression	
			Unsuppressed	Suppressed
Adherence to HIV care				
No	49	8.2	24 (11.5%)	25 (6.4%)
Yes	552	91.8	185 (88.5%)	367 (93.6%)
Total	601	100.0	209	392
Missing system	1			
Total	602			
Retention in care				
No				
Yes	92	15.3	35 (16.7%)	57 (14.5%)
Total	510	84.7	175 (83.3%)	335 (85.5%)
	602	100.0	210	392
Linkage to HIV care				
No	49	8.1	17 (8.1%)	32 (8.2%)
Yes	553	91.9	193 (91.9%)	360 (91.8%)
Total	602	100.0	210	392
Currently on heart disease treatment				
No				
Yes	453	75.2	148 (70.5%)	305 (77.8%)
Total	149	24.8	62(29.5%)	87 (22.2%)
	602	100.0	210	392
Currently on hypertension treatment				
No	90	15.0	29 (13.8%)	61 (15.6%)
Yes	512	85.0	181 (86.2%)	331 (84.4%)
Total	602	100	210	392

Table 4

Descriptive Statistics Showing Frequencies, Percentages, and Viral Suppression of the Study Socioeconomic Covariate Variables

Study variables	Frequency	Valid Percent	Viral Suppression	
			Unsuppressed	Suppressed
Alcohol use				
No	535	95.7	186 (96.4%)	349(95.4%)
Yes	24	4.3	7 (3.6%)	17 (4.6%)
Total	559	100.0	193	366
Missing System	43			
Total	602			
Highest education				
0-7 (completed Pre/primary school) (1)	167	27.7	57 (27.1%)	110 (28.1%)
8-12 (completed secondary school) (2)	389	64.6	141 (67.1%)	248 (63.3%)
13-15(completed diploma, undergraduate/post-graduate courses) (3).	46	7.6	12 (5.7%)	34 (8.7%)
	602	100.0	210	392
Total				
Medics are paid by Medical Aid				
No	70	11.6	33 (15.7%)	37 (9.4%)
Yes	532	88.4	177 (84.3%)	335 (90.6%)
Total	602	100.0	210	392

Table 5

Summaries of the Basic Logistic Regression Model Showing Risk Factors (Covariate Variables) for Viral Suppression (Study Outcome) of HIV-Infected aged 18 – 49 in Johannesburg (Variables in the Equation Showing Bivariate Regression Model that included only Exposure and Outcome)

Risk Factor	Unadjusted Odds ratio	95% C.I. Lower	95% C.I. Upper	Sig.
Bills paid by Medical Aids	1.789	1.082	2.957	**.023***
Currently taking ARV's treatment	.991	.536	1.830	.977
Having disability	.720	.324	1.597	.419
Use of alcohol	1.294	.527	3.177	.573
Ever missed ARV treatment	1.175	.743	1.860	.490
Currently taking Heart Disease medication	.681	.465	.996	**.048***
Currently taking HIV medication	1.904	1.059	3.426	**.032***

Table 6

Summaries of the Basic Logistic Regression Model Showing Risk Factors (Covariate Variables) for Viral Suppression (Study Outcome) of HIV-Infected aged 18 – 49 in Johannesburg (Continued)

Risk Factor	Unadjusted Odds ratio	95% C.I. Lower	95% C.I. Upper	Sig.
Present employment situation	1.017	.896	1.154	.795
Currently taking Hypertension medication	.869	.539	1.402	.566
Race of respondent	.973	.728	1.300	.852
Sex of respondent	1.343	.936	1.929	.110
Marital status	1.146	.941	1.395	.177
Highest educational level obtained	1.067	.791	1.440	.670

Assessment of single risk factors such as listed in Table 6 above and viral suppression. I conducted logistic regression to determine if the covariate variables were related to the study's independent and dependent variables.

Analysis of medical bills paid by medical aids and viral suppression had the OR= 1.789, (1.082, 2.957), p=0.023 (p<0.05), this was statistically significant, meaning that medical aids were associated with a higher odds, as stated above. Therefore I used medical bills paid by medical aids to adjust the odds ratio. The variable linkage to HIV care (Are you currently taking ARS's, that is antiretroviral treatment daily?) and viral suppression had the OR= 0.991, (0.536, 1.830), p= .977 (>0.05), which was not statistically significant, meaning that this variable did not have a strong association with the study dependent variable, therefore, I did not include it in the final regression model.

Analysis conducted using the variable disability (Do you have a disability?) and viral suppression revealed the OR=.720, (0.324, 1.597), p=.419 (p>0.05). This was not statistically significant; hence, this variable was not included in the final logistic regression model. The analysis of alcohol use (Do you use alcohol?) and viral suppression revealed the OR = 1.294, (0.527, 3.177), p= .573 (p>0.05) this association was not statistically significant; this means that it did not have an association with the study outcome, therefore was not included in the final regression model.

The analysis conducted with the variables retention to care (Have you ever missed ARV treatment?) and viral suppression revealed the OR= 1.175, (0.743, 1.860), p= .490 (p>0.05), this was not statistically significant, hence, was not included in the final regression analysis. The analysis conducted using the covariate variable heart disease treatment (Heart Disease, Are you currently taking medication?) and the outcome variable (viral suppression) revealed the OR = 0.681, (0.465, 0.996), p=0.048 (p<0.05). This was statistically significant but was not included in the final regression model because heart disease patients were different population from diabetes, cancer, and TB patients. Heart disease patients in this study were patients who were co-treating HIV and heart disease, however, the focus of this study was on patients cotreating HIV with diabetes, cancer, or TB, and not heart disease.

Analysis performed with the covariate variable HIV_ treatment (HIV_ Are you currently taking medication?) and viral suppression revealed an increased OR = 1.904, (1.059, 3.426), p= 0.032 (p<0.05). This means that the odds of viral suppression were 1.904 among HIV patients currently on treatment, and the association was statistically significant. However, I did not include this variable in the final regression model, since it is in the causal pathway it is considered a mediator and it should not be adjusted for as a confounder in this study (Jager et al, 2007). However, the result of the basic logistic regression model conducted in this study between currently taking HIV medication and viral suppression validated the above mentioned assertion, which is a strong association with viral suppression.

The covariate variable employment status (How would you describe your present employment situation?) and viral suppression analysis conducted revealed OR= 1.017, (0.896, 1.154), p=.794 (p>0.05), this was not statistically significant, therefore was not eligible to be included in the final model. Analysis of being on hypertension treatment (Hypertension_ Are you currently taking medication?) and viral suppression revealed the OR= 0.869, (0.539, 1.402), p= .566 (p>0.05), which was not statistically significant and was not ineligible to be included in the final model. The analysis of the Race of respondents and viral suppression revealed the OR = 0.973, (0.728, 1.300), p= .852 (p>0.05), this was not statistically significant, therefore was excluded in the final model. The analysis of sex of respondents and viral suppression revealed the OR=1.343, (0.936, 1.929), p=.110 (p>0.05). The result was not statistically significant, therefore was not eligible to be used for odds ratio adjustment in this study. The age of the study respondents which was proposed to be used as a covariate in this study had only one (1) value in the secondary dataset (15-49 =1).There was no grouping of the age brackets within this age based on the dataset; therefore age was not incorporated in the study model. The analysis of marital status (What is your marital status?) and viral suppression revealed the OR= 1.146, (0.941, 1.395), p= .177, this was not statistically significant, hence was not used in the final model. The analysis of educational level obtained (What is the highest educational level that you have obtained?) and viral suppression revealed the OR= 1.067, (0.791, 1.440) p= .670 ($p>0.05$), therefore the result was not statistically significant; therefore, it was not used in the final model.

In this study, I conducted a logistic regression analysis to determine the relationship between treatment of comorbidities such as diabetes, cancer, TB, and viral suppression among adults aged 18 to 49 who were HIV-infected in Johannesburg South Africa.

Table 7

Basic Logistic Regression Model Showing the Unadjusted Odds Ratio Relating RQ1 Diabetes Treatment and Viral Suppression among HIV-Infected Adults Aged 18 – 48 in Johannesburg

Study Variables	B	S.E.	Wald	df	Odds ratio**	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking Diabetes medication	.014	.209	.005	1	1.015	.674	1.527	.945
Constant	.637	.182	12.220	1	1.891			.000

a. Variable(s) entered on step 1: Diabetes_ Are you currently taking medication?

In the basic model that I conducted to answer the research question one, which was to determine if a relationship existed between diabetes treatment and viral suppression among HIV-infected adults aged 18-49 in Johannesburg, the result revealed that the odds of viral suppression were OR 1.015 among diabetes patients currently on treatment. However, the association was not statistically significant. The OR= 1.015, (0.674, 1.527) and the*p*-value = 0.945 shows that the CI spans 1 and the *p*-value is 0.945 (p>0.05), which indicates non-statistical significant association. I performed a basic logistic regression model to determine whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had diabetes in Johannesburg, and the result revealed that PLWHIV who were currently taking diabetes treatment had the unadjusted log-odds OR= 1.015 [0.674, 1.527]. This means that HIV-infected patients who were on diabetes treatment had the OR= 1.015 of being virally suppressed compared to PLWHIV who had diabetes but were not on diabetes treatment. The 95% confidence intervals of the odds ratio were 0.674, 1.527, and the p = 0.945, however, it was not statistically significant.

Table 8

Final Logistic Regression Model Showing the Adjusted Odds Ratio (Adjusted with Medical Bills Paid by Medical Aids, Hence Associated with the Outcome) Relating Diabetes Treatment and Viral Suppression among HIV-Infected Adults in Johannesburg

Study Variables	Unadjusted Odds ratio	95% C.I. Lower	95% C.I. Upper	Sig.	Adjusted Odds ratio**	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking Diabetes medication	1.015	0.674	1.527	.94	.993	.658	1.498	0.97
Medical bills paid by medical aid	1.789	1.082	2.957	**.02***	1.757	1.042	2.964	**0.03***

Assessment of single risk factor but adjusted for confounder (medical bill payment by medical Aid).

The adjusted odds with the covariate variable medical bills paid by medical aids was OR=0.993 (0.658, 1.498), p=0.97 (p>0.05). This means that the odds of viral suppression were 0.918 among diabetes patients currently on treatment, but the association was not statistically significant. The lower confidence interval (CI) was less than 1 and the upper (higher) confidence interval was higher than 1, which also confirms that the association was not statistically significant. The covariate variable that was used in adjusting the Odds ratio was medical bills paid by medical aid unadjusted OR = 1.789, (1.082, 2.957) and adjusted OR = 1.762, (1.042, 2.980), with the p = .03 and p =.02 respectively. Medical bills paid by medical aids had an effect on the independent and the dependent variables in this study. This was explained by the difference between the unadjusted OR = 1.015 and the adjusted OR = .993. The overall model statistic was X^2 (2, N = 602) = 8.783, p = .112, and the classification table indicated that the model was 66% correct. The variance = R, $R^{2,}$ indicated that between 8% and 11% of the variance in the dependent variable was explained by the independent and the covariate variable used in the analysis which was the study model.

Table 9

Basic Logistic Regression Model Showing the Unadjusted Odds Ratio Relating RQ2 Cancer Treatment and Viral Suppression among HIV-Infected Adults Ages 18 – 49 in Johannesburg.

Study Variables	B	S.E.	Wald	df	Unadjusted Odds ratio	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking Cancer medication	.218	.193	1.272	1	1.243	.852	1.815	.259
Constant	.492	.156	9.935	1	1.636			**.002***

a. Variable(s) entered on step 1: Cancer_ Are you currently taking medication?

I conducted a basic model of the logistic regression analysis to answer research question two, which was to determine whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 and 49 who had cancer in Johannesburg. The result revealed that PLWHIV who were currently taking cancer treatment had the unadjusted log OR= 1.243 [0.852, 1.815], which means that cancer patients who were currently on cancer treatment had the odds of viral suppression1.243compared to those that were not on treatment, but the association was not statistically significant. The 95% confidence interval of the odds ratio indicated. The lower confidence interval (CI) was less than 1 and the upper (higher) confidence interval was higher than 1, the *p*-value was 0.259 (p>0.05) therefore, the association was not statistically significant. See table 9 above.

Table 10 below visually displays the summary of the final model for the relationship between treatment of comorbidities such as cancer and viral suppression among HIV-infected adults aged18 – 49 in Johannesburg. I utilized the medical bills paid by medical aids to adjust the odds ratio in the final model.

Table 10

Final Logistic Regression Model Showing the Adjusted Odds Ratio (Adjusted With Medical Bills Paid by Medical Aids, Hence Associated With the Outcome) Relating Cancer Treatment and Viral Suppression Among HIV-Infected Adults in Johannesburg

Study Variables	Unadjusted Odds ratio	95% C.I. Lower	95% C.I. Upper	Sig.	Adjusted Odds ratio**	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking Cancer medication	1.243	.852	1.815	.25	1.234	.844	1.805	**0.27***
Medical bills paid by medical aid	1.789	1.082	2.957	**.02***	1.703	.993	2.923	**.05***

Assessment of single risk factor but adjusted for confounder (medical bill payment by medical Aid). The adjusted odds for cancer treatment and viral suppression was OR= 1.234, (0.844, 1.805), adjusted *p*=value (*p*=0.27), p>0.05. It means that cancer patients who were on treatment had the OR=1.234 of being virally suppressed that of cancer patients who were not on cancer treatment, however, the association was not statistically significant because OR was 1.2, CI spans 1, and the *p*-value was *p*>0.05. The overall model statistic was X^2 (2, N = 602) = 4.936, p = .085, and the classification table indicated that the model was 65% correct. The variance = R, $R^{2,}$ indicated that between

9% and 13% of the variance in the dependent variable was explained by the independent and the covariate variable used in the analysis which was the study model.

Table 11

Basic Logistic Regression Model Showing the Unadjusted Odds Ratio Relating RQ3 TB Treatment and Viral Suppression among HIV-Infected Adults Ages 18 – 49 in Johannesburg

Study Variables	B	S.E.	Wald	df	Unadjusted Odds ratio	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking TB medication	.442	.191	5.351	1	1.556	1.070	2.263	**.021***
Constant	.493	.101	23.672	1	1.637			.000

a. Variable(s) entered on step 1: TB_ Are you currently taking medication?

In the basic model that I performed to determine whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had TB in Johannesburg. The result revealed that PLWHIV who were currently taking TB treatment had the unadjusted log OR= 1.556 [1.070, 2.263]. This means that the unadjusted odds of viral suppression were 1.556 among TB patients currently on treatment, and the association was statistically significant. Hence, the 95% confidence intervals of the odds ratio were1.070, 2.263, and the *p*-value was 0.021 (p<0.05).

Table 12

Final Logistic Regression Model Showing the Adjusted Odds Ratio (Adjusted With Medical Bills Paid by Medical Aids, Hence Associated With the Outcome) Relating TB Treatment and Viral Suppression Among HIV-Infected Adults in Johannesburg

Study Variables	Unadjusted Odds ratio	95% C.I. Lower	95% C.I. Upper	Sig.	Adjusted Odds ratio**	95% C.I. for EXP(B) Lower	95% C.I. for EXP(B) Upper	Sig.
Currently taking TB medication	1.556	1.070	2.263	**.02***	1.534	1.053	2.234	**.02***
Medical bills paid by medical aid	1.789	1.082	2.957	**.02***	1.751	1.057	2.902	**.03***

Assessment of single risk factor but adjusted for confounder (medical bill payment by medical Aid). I conducted logistic regression to answer research question three which was to determine the relationship between treatment of comorbidities (TB) and viral suppression among HIV-infected adults aged 18-49 in Johannesburg adjusting the odds with medical bills paid by medical aids for the final model. The results revealed the adjusted OR= 1.534, (1.053, 2.234), and p= 0.02. This means that the odds of viral suppression were 1.534 among TB patients currently on treatment, and the association was statistically significant. TB patients who were currently on TB treatment at the time data for this study was collected had increased odds OR= 1.5 viral suppression compared to TB patients who were not on TB treatment.

Medical bills paid by medical aids had unadjusted OR= 1.789, (1.082, 2.957), p= 0.02 (p<0.05). This result was statistically significant and revealed a strong association between TB treatment and viral suppression. The overall model statistic was X^2 (2, N = 602) = 10.151, p = .006, and the classification table indicated that the model was 65%

correct. The variance = R, $R^{2,}$ indicated that between 17% and 23% of the variance in the dependent variable was explained by the independent and the covariate variable used in the analysis which was the study model.

In conclusion, null hypothesis three which was stated that there was no relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had TB in Johannesburg was rejected. The null hypotheses one of there was no relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had diabetes in Johannesburg and the null hypothesis two that there was no relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had cancer in Johannesburg were accepted. I also discussed study results, conclusions and recommendations in chapter five.

Chapter 5

Introduction

In this study, I purposed to determine whether a relationship existed between treatments of comorbidities such as diabetes, cancer, TB and viral suppression among HIV-infected people aged 18 – 49 in Johannesburg South Africa. I conducted descriptive statistics analysis which included frequencies and percentages of the study variables and the covariates.

I also performed logistic regression analysis to determine whether a relationship existed between the treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had diabetes in Johannesburg. The relationship between the variables was not statistically significant; therefore the null hypothesis was accepted. This result indicates that diabetes patients on treatment had the odds 1.015 of being virally suppressed. The result revealed that diabetic patients who were on treatment had an adjusted odds ratio of 0. 993 of viral suppression. I conducted the final model to answer research question one using the independent variable currently taking diabetes treatment, covariate variable medical bills paid by medical aids, and viral suppression. The result revealed no statistical significance between diabetes treatment, medical bills paid by medical aids and viral suppression, and the null hypothesis was accepted. The classification table indicated that the model was 66% correct.

In this study, I performed logistic regression to determine the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had cancer in Johannesburg indicated that the unadjusted odds of viral suppression were 1.243 among those taking cancer medications but the association was not statistically significant, because the CI spans 1 and the p-value was above conventional levels. In the final model, the result revealed that the odds of viral suppression were 1.234 among those currently taking cancer medications but the association was not statistically significant, because the CI spans 1 and the p-value was above the conventional levels, therefore, the null hypothesis was accepted. The classification table indicated that the model was 66% correct. The variance = R, $R^{2,}$ indicated that between 9% and 13% of the variance in the dependent variable was explained by the independent variables which was the study model that answered the research question two.

I performed logistic regression to determine the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had TB in Johannesburg; the result was statistically significant, and the null hypothesis was rejected. This means that the odds of viral suppression were 1.556 among patients taking TB medications. In the adjusted model, the result further indicated that the odds of viral suppression were 1.534 among those taking diabetes medications and the association was statistically significant. The null hypotheses were also rejected. The classification table indicated that the model was 66% correct. The variance = R, $R^{2,}$ indicated that between 17% and 23% of the variance in the dependent variable was explained by the independent and the covariate variables which was the study model.

Discussions

This study was based on the HIV care continuum theoretical framework, established in 2013 through the executive order of the then United States of America President Barrack Obama. The HCC was aimed to prioritize the establishment of national indicators for HIV care (Centers for Disease Control and Prevention, 2014). This public health model HCC consists of five steps which include infection diagnosis, linkage to HIV care, receipt of HIV care, retention to care, achievement and maintenance of viral suppression. These are the steps that people infected with HIV go through from diagnosis to achieving and maintaining viral load suppression (Kay et al., 2016). In this study, I determined the treatment of comorbidities and viral suppression among adults aged. 18 – 49 who had diabetes in Johannesburg were statistically not significant. This result is in line with the finding of Chang et al. (2019), who explained that diabetes was not associated with progression in care, unlike patients with hypertension comorbidity, who had greater progression in care. However, this result extends knowledge in the field of public health on the topic studied.

The findings of this study show that there was a statistically significant association between treatment of comorbidities such as TB and viral suppression among HIV-infected adults aged 18 – 49 in Johannesburg. The association was observed both in the crude and adjusted odds ratio; refer to tables 11 and 12 in Chapter 4. This indicated that HIV-infected adults who were currently co-treating TB and HIV had a higher odds ratio of being virally suppressed. These findings align with the theory of HCC, specifically the theory's construct of treatment and viral suppression explains and supports these findings (Centers for Disease Control and Prevention, 2019; Kay et al., 2016). In the study by Ernesha et al. (2016), patients co-infected with TB and HIV were more likely to adhere to TB treatment compared to antiretroviral treatment.

In this study, medical bills paid by medical aids was the only covariate variable associated with the study outcome, this means that medical bills paid by medical aids had an association with viral suppression in this study. Refer to table 5on page 55, table 7 on page 60, and table9 on page 63 and table 12 on page 66. Medical bills paid by medical aids were incorporated as a covariate in the final models of the three research questions because it was associated with the independent and the dependent variables of this study. This variable was also not evenly distributed to the study participants, it was not in a causal pathway, and it was statistically significant in the basic model, and was incorporated in the proposal phase. Medical bills paid by medical aids seem to have a strong association with viral suppression, because people who have help with medical care are more likely to use it. Marinda et al. (2020) reported that linkage to care and retention to ART are areas of deficiencies that affect the achievement of viral suppression in South Africa, which is in line with the results of this study. In this study, medical aid payment was associated with viral suppression compared to medical aid nonpayment, and this result correlated with the findings of Geter et al. (2019), which showed an association between the use of private insurance and viral suppression.

The result of this study also revealed that no significant associations existed between sex, race, educational qualification, marital status, employment status, disability, alcohol use, and viral suppression. The findings were similar to the findings of

Rangarajan et al. (2016) which reported that no significant association existed between wealth index, sex, educational level, marital status, residential location, and viral suppression. Lokpo et al. (2020) also found that sex does not have a significant relationship with viral suppression. This conflict with the findings of Rangarajan et al. (2016) that showed that the rate of viral suppression in men is higher compared to that of women within the same time of being on ART.

In this study, PLWHIV who were currently on hypertension treatment had the odds 0.869 of being virally suppressed; however, hypertension treatment was not statistically significant or negative effect. Linkage to HIV care and retention to HIV care are roads to viral suppression (CDC, 2019). It is a gold standard for achieving and maintaining viral suppression. In this study, PLWHIV who were linked to HIV care and retained to HIV care had the lower odds of achieving viral suppression compared to PLWHIV who were not linked and retained to treatment; hence, this association was not statistically significant. Kay et al.'s (2019) study showed that missed medical appointments are significantly associated with lower CD4 count and higher viral loads.

Limitations of the Study

HIV prevalence in South Africa crosses across all ages and provinces, but this study focused only on adults aged between 18 – 49 who co-treated other chronic diseases and health conditions such as diabetes, cancer, or TB with HIV, which could limit the generalization of the results of this study; however, the ages of 18 – 49 represented the highest number of people infected with HIV in South Africa (StatsSA, 2017); which is in line with findings of other researchers conducted in other countries of the world

(UNAIDS., 2016 – 2021). This study was limited to only HIV patients with health conditions such as diabetes, cancer, or TB, whereas HIV-infected patients may have co-treated other health conditions other than the above mentioned three predictive health conditions, and that may have affected the generalization of the results. This study included all HIV-infected patients receiving treatment for diabetes, cancer, or TB, without specifying the type of treatment or drug a patient was using for a specific health condition, which may have affected the internal and external validity (findings) of the study. This study included all males and females in the age bracket selected for this study. However, the age of the study respondents which was proposed to be used as a covariate in this study had only one value in the secondary dataset (15 – 49 =1) used for analysis. There was no grouping of the age brackets within this age based on the dataset; therefore, age was not incorporated in the study final model. Sex was also proposed as a confounder in this study; however, it was not included in the regression final model, and hence, it was statistically insignificant. Although previous studies showed that women are most likely to adhere to treatment than their male counterparts.

Conclusions

HIV has infected over 37.9 million people around the world. An estimated 23.3 million (62%) of the infected people are on ARTUNAIDS, 2016), and the treatment effectively suppresses viral load and viral transmission (Kay et al., 2016; UNAIDS, 2016). However, insufficient viral load suppression remains a major problem in the HIV care continuum in South Africa. Hence, this study purposed to determine whether a relationship existed between the treatment of comorbidities and viral suppression among

HIV-infected adults aged 18 – 49 who were diabetic, had cancer, or had TB in Johannesburg South Africa. The dependent variable was viral suppression, and the three independent variables included currently being on diabetes treatment, cancer treatment, and TB treatment. I utilized a secondary dataset from HSRC for analysis based on the approval granted for the data access. I also selected a sample of 602 from the original dataset which formed a sub dataset for the study.

I concluded that treatment of comorbidities such as TB has a positive impact on viral suppression outcomes. While it is necessary to conduct further studies using different datasets and populations to determine the relationship between treatment of comorbidities such as diabetes, cancer, and viral suppression, the findings inform policy and influences decision on care and management of PLWHIV with comorbidities in Johannesburg. This study contributes to positive social change by highlighting the effect of the treatment of comorbidities on viral suppression in PLWHIV in an under-resourced setting. This study positively filled the gap in the field of public health literature on the relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 in Johannesburg South Africa. This study finds that a concurrent, simultaneous, or integrated treatment model of comorbidities among HIV-infected persons in the communities helps to achieve viral suppression, and treatment of the whole person to reduce HIV prevalence and possibly attainment of an HIV-free society.

Recommendations

HIV has continued to mount pressure (burden) on South Africa's workforce, economy, growth, development, population, and GDP (UNAIDS, 2016) despite government, individual, and organizational efforts to combat the disease. The rate of viral load suppression among adults aged 18 – 49 may have been influenced by non-adherence to treatment, interruption of treatment, and loss to follow-up of patients enrolled for treatment, and these factors have been suggested to contribute to high mortality and morbidity of people infected with HIV in South Africa (Ekeji, 2016; Galea et al., 2018; StatsSA, 2017). Based on the findings of this study, I recommend that PLWHIV who are also having other health conditions such as diabetes, cancer, and TB should be linked to care as soon as possible, retained to care, and monitored for treatment adherence to ensure achievement of not only viral suppression but improved health. The government and public health professionals should plan, enact and implement further policies and programs on how to ensure that PLWHIV with comorbidities are prioritized in treatment/ medication to improve viral load suppression.

I recommend that all patients co-treating HIV and TB be linked to care, retained in care, encouraged to adhere to treatment (by reminding patients of time to take medication using family members, friends, caregivers, or technology such as cell phone, social media, WhatsApp, and S planner) to be able to achieve and maintain viral suppression. Health promotional campaigns focused on creating awareness of how to achieve viral suppression even with the treatment of comorbidities should be encouraged by the government, non-governmental organizations, and individuals to improve the health of South Africans. It is of utmost importance to indicate that the treatment of comorbidities such as TB and HIV has been part of government health policies in South Africa (Gauteng Department of Health, 2020). It is a government policy to test every new TB patient for HIV in Gauteng Province (Gauteng Department of Health, 2020). I recommend education of people through mass media and social media on the importance of taking treatment/medication of other health conditions along with ARV to improve viral suppression.

The findings of this study indicated no relationship between treatment of comorbidities and viral suppression among HIV-infected adults aged 18 – 49 who had diabetes, and those that had cancer in Johannesburg South Africa. However, I recommend further studies using different populations and different datasets to determine if relationships exist between the treatment of diabetes or cancer and viral suppression among PLWHIV. In this study, the focus was on patients who were currently on any treatment for diabetes, cancer, or TB, but not on the type of diabetes treatment, type of cancer treatment or type of TB treatment, and type of medication that a patient is taking may that affect the patient's viral suppression. Hence, I recommend further study on the effect of type of medication on viral suppression.

Medical bills paid by medical aid were associated with viral suppression in this study. I, therefore, recommend that all people infected with HIV be encouraged to join medical aids insurance, since people who have help with medical care are more likely to use it and improve health. The government of South Africa should expedite actions to pass the current National Health Insurance (NHI) bill into law and implement the same as soon as possible, to help improve the achievement and maintenance of viral suppression of PLWHIV which in turn would improve the entire health of South Africans. An integrated action model on comorbidities to achieve viral suppression and to treat the whole person will help to free Johannesburg from HIV infections.

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