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Dynamics of HIV chronic comorbidities among adults in South Africa: A population-based mixed methods study

By

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This thesis is submitted in fulfilment for the degree of Doctor of Philosophy in the department of Demography and Population Studies

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DEDICATION

I dedicate this work to my grandmother, Rephina Kwenaite. Through it all, you've always held my hand. I would have never come this far without your prayers. Kealeboga Moratiwa!

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Firstly, thank you sweet, Jesus. I have achieved all that I have not because of my own strength but because of your will. For this, I am grateful and will forever worship you.

To my husband, you know best the highs and the lows that this journey has brought for me and for us. From watching me quit my job to register for the PhD, to watching me want to quit the PhD, to watching me find my rhythm in writing again. Thank you for being present right from the start, for staying up with me till the early mornings, for cheering me up when it became difficult. Thank you for taking care of everything else so I can take care of this.

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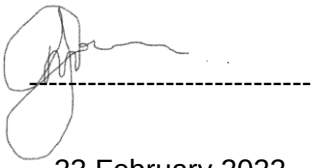
God bless you all!

DECLARATION

I, Motlatso Godongwana, declare that this thesis is my own original work.

It is being submitted for the degree of Doctor of Philosophy in Demography and Population Studies within the Schools of Social Science and Public Health at the University of the Witwatersrand, Johannesburg, South Africa.

To the best of my knowledge, it has not been submitted before, in part or in full, for any degree or examination at this or any other University.



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LIST OF ACRONYMS

AIDS – Acquired Immune Deficiency Syndrome

ART – Antiretroviral Therapy

AGYW – Adolescent Girls and Young Women

BMI – Body Mass Index

CVD – Cardiovascular Disease

CCM – Chronic Comorbidity

CDRP – Chronic Disease Rehabilitation Programme

CCDM – Chronic Care Disease Model

CSM – Continuing Sampling Members

DOH – Department of Health

EC – Eastern Cape

GDP – Gross Domestic Product

GP – Gauteng

HAART – Highly Active Antiretroviral Therapy

HCW – Healthcare Workers

HIV – Human Immunodeficiency Virus

HSRC – Human Sciences Research Council

HREC – Human Research Ethics Committee

HBP – High Blood Pressure

IDI – In-depth Interviews

ICDM – Integrated Chronic Disease Model

NCDs – Non Communicable Diseases

NIDS – National Income Dynamics Survey

NIHSS – National Institute for the Humanities and Social Sciences

NNRTIs – Non Nucleoside Reverse Transptase Inhibitor

NGO – Non-Governmental Organizations

PMTCT – Prevention of Mother to Child Transmission

PHC - Primary HealthCare

PLWH – People Living With HIV

SA – South Africa

SSA – Sub Saharan Africa

SAGE – Study of Global Aging

SANAC – South African National AIDS Council

SDH – Social Determinants of Health

SDGs – Sustainable Development Goals

SAHUDA – South African Humanities Deans Association

TB – Tuberculosis

UNAIDS – United Nations Programme on HIV/AIDS

UNICEF - United Nations Children's Fund

US – United States

VMC – Vector Model of Complexity

WHO – World Health Organisation

Definition of Terms

The key words in the study are defined as follows:

- **HIV**: The human immunodeficiency virus that attacks the body's immune system and if left untreated can lead to the development of AIDS.
- **PLWH**: In this study PLWH refer to adults that have tested positive for HIV and are living with HIV at the time of the NIDS survey.
- **Chronic disease**: Refers to medical conditions that are long in duration and cause functional restrictions that require ongoing treatment and care (Raghupathi & Raghupathi, 2018). In this study they include any of following diseases: HIV, heart problems, diabetes, hypertension, mental disorder (broadly conceived) (Bernell & Howard, 2016).
- **Index disease**: One disease that is taken as the point of reference in the presence of two or more other diseases (García-Olmos et al., 2012). In this study, HIV is the index disease.
- **Co-morbidity**: Refers to the presence of two chronic diseases within the same individual whereby one condition represents the index disease (Mutyambizi et al., 2017).
- **Time to second diagnosis**: Refers to the age (in years) by which a person diagnosed with HIV develops an additional chronic condition.
- **Adult**: Describes persons aged 18 – 65 years old in this study.
- **Hypertension:** 140/90 mm Hg and/or being on antihypertensive treatment.

ABSTRACT

Background: People living with HIV (PLWH) are at an increased risk of developing additional chronic conditions, globally. In South Africa, the prevalence of HIV Chronic Co-Morbidities (HIV CCMs) ranges from 20% to 60%. Both PLWH and HIV negative people with a family history of chronic conditions and who engage in chronic risk factors - such as smoking, alcohol use, physical inactivity, and poor diet – have an increased risk of developing hypertension and other cardiovascular diseases. Older age, females and low levels of income are other known predictors of HIV CCMs. Further, research shows that Anti-Retroviral Therapy (ART) and duration of HIV infection increase the risk of HIV CCMs. With the growing prevalence (20.4%) of HIV among adults in South Africa and the progress made to initiate all HIV infected persons on ART, the rate of HIV CCMs is expected to rise. The increase in HIV CCMs is a challenge because the treatment and care for patients places strain on the health system. It is associated with increased health costs and resources, both financially and in the use of health services and healthcare providers. More so, HIV CCMs may result in an overall decrease in quality of life and, worse, mortality. Research has identified the levels, factors and consequences associated with HIV CCMs. Therefore, the main objectives of this study are to assess the time taken before adults living with HIV develop a second chronic condition and the challenges experienced by persons living with HIV CCMs in South Africa.

Methods: This study applied a mixed-methods research design. It began by retrospectively analysing longitudinal data from the National Income Dynamics Survey (NIDS). This was done to assess the time (represented by age) before PLWH develop either hypertension, diabetes, cardiovascular disease, stroke, or cancer. The data comprises of five waves between 2008 and 2017. The target population was adults aged 18 – 75 years' old who were HIV positive at wave 1 (n=95 701) and developed any of the chronic conditions by wave 3 (2015) or wave 5 (2017). Analysis was conducted in STATA using the Cox Proportional Hazard Models. Further, to understand challenges pertaining to prevention, access to treatment and management faced by persons living with of HIV CCMs, in-depth interviews using a phenomenological approach were conducted with HIV CCM diagnosed patients as well as healthcare providers.

Results: In this study, out of all chronic conditions assessed, PLWH were at higher risk of hypertension (10.59%). The outcomes of the Kaplan Meier estimates show that the risk of developing HIV and hypertension Comorbidity is highest between the ages 30 – 46 years. In other words, a person diagnosed with HIV between the age of 15 - 24 is likely to become at risk of hypertension at minimum after 15 years of HIV diagnosis if diagnosed at the age of 15 and remain at risk for over 15 proceeding years. Results from the adjusted Cox model show

that none of the demographic and socio-economic (marital status; level of income; level of education; place of residence; ethnicity; religion) and health characteristics (alcohol and tobacco use; exercise, perceived health status and last doctor's consultation) were significantly associated with the development of hypertension adults living with HIV in this study. Additionally, the interviews with the HCWs and patients show that lack of adequate information on the prevention of HIV CCMs, polypharmacy, stigma, unemployment, and long travel distance to the health facility are barriers for the prevention and management of HIV CCMs for patients. At a health system level, limited staff capacity and lack of training in the delivery of the Integrated Chronic Disease Model (ICDM) threaten the ability of healthcare providers to adequately treat and care for persons living with HIV CCMs.

Conclusion: This study concludes that HIV infected persons need to routinely screen for chronic diseases, especially hypertension during ART consultation. These screening services, HIV and chronic disease prevention programmes should include all persons infected with HIV, particularly the youth who have shown to be at increased risk of not only HIV but hypertension Comorbidity as well. This should be done in order to assist them to prevent the development of HIV CCMs. Educational institutions organisations should be engaged in HIV and chronic prevention initiates as they are a trusted source of information for young people. As a step to address some of the socio-economic challenges affecting persons with HIV CCMs, HIV and chronic disease programmes in South Africa can invest in transferring HIV and chronic care services from the clinic to the home and providing food aids. Finally, the ICDM model in South Africa needs to be strengthened by increasing training initiatives, ensuring that the training and guidelines are standardized, and investing in health and promotion.

CHAPTER ONE: INTRODUCTION

1.1. Background

Chronic diseases are defined as medical conditions that are long in duration and cause functional restrictions that require ongoing treatment and care (Raghupathi & Raghupathi, 2018). Advancement in Anti-Retroviral Therapy (ART) has improved the health outcomes and prolonged the lives of people infected with HIV (Deeks, Lewin, et al., 2013). As a result, HIV is now classified as a manageable chronic illness. However, people living with HIV (PLWH) are also developing other age-related chronic conditions (Deeks, Lewin, et al., 2013). Common chronic conditions include non-communicable diseases (NCDs) such as Cardiovascular Diseases (CVD), cancer, chronic respiratory diseases, diabetes, as well as mental health illnesses (Islam et al., 2014). Theses chronic diseases have become the leading cause of mortality worldwide, accounting for over 70% of all deaths (WHO, 2018a). In South Africa, almost 60% of all deaths are due to chronic diseases (STATS SA, 2017).

Chronic ComorbidityComorbidity (CCM) is the presence of two or more chronic conditions within the same individual, whereby one of the conditions represents the index disease (Mutyambizi et al., 2017). The prevalence of CCM is high globally. At least one third of the global population suffers from a CCM (Hajat & Stein, 2018). Rates of CCM are 72% in Russia and 45.1% in China (Garin et al., 2016). In these countries, CCM is normally as result of a combination of cardio-respiratory COPD) and metabolic chronic diseases such as diabetes, hypertension and obesity (Garin et al., 2016). Research in developing countries have shown CCM prevalence ranging from 48% – 63% (Garin et al., 2016). The combination of chronic diseases in these countries are the same as in Russia and China (Garin et al., 2016).

Data from around the world has shown that the prevalence of HIV CCM is also high. A retrospective study in London found that about 29% of HIV infected persons had a Comorbidity (Lorenc et al., 2014). In this study, common comorbid conditions were hepatitis, mental health disorders and CVD (Lorenc et al., 2014). Similarly, studies in South Africa have shown that almost 30% of PLWH had at least one other Comorbidity (Negin et al., 2012b; Nlooto, 2017). HIV and Hypertension were the most prevalent CCMs in these studies. In a recent study conducted in Ethiopia over half (51.3%) of PLWH were diagnosed with at least one NCD (Woldesemayat, 2020). In Germany, at least 12% of PLWH were diagnosed with CVD in one study (Christensen et al., 2019). A study conducted in the US showed that PLWH had higher prevalence of diabetes (28.8%), hypertension (46.9%), and stroke (3.3%) compared to their HIV negative counterparts (Yang et al., 2019a). According to recent data (2018), the global

prevalence of hypertension in PLWH is estimated at about 9% and at least 59% of these living in sub-Saharan Africa (Bigna et al., 2020).

Research on HIV transmission and chronic disease risk factors is widely available and known. Factors known to increase HIV infection are risky sexual behaviour, blood transmission, and mother-to-child transmission. Other chronic conditions such as CVD, cancer, chronic respiratory diseases, diabetes, and hypertension occur because of chronic risk factors. Risk factors include physical inactivity, unhealthy diet, tobacco use, alcohol abuse, high cholesterol and hypertension (Lucero et al., 2014; Van Remoortel et al., 2013). The risk of HIV CCM is increased among PLWH that are exposed to chronic diseases risk factors (Deeks, Lewin, et al., 2013).

The risk of developing CCM has also been associated with a number of socio-demographic characteristics including age, BMI, race, sex, place of residence, level of education and employment status (Negin et al., 2012; Saeed et al., 2013; Steenkamp et al., 2014). Research shows that the risk of chronic diseases increases as people age and the population most affected by these diseases are adults aged over 50 years (Fabbri et al., 2015; Maciel et al., 2018a). Ageing has been associated with an increased susceptibility to develop chronic diseases because of the accumulated and long-term exposure to chronic risk factors (Fabbri et al., 2015). The deterioration in levels of physical activity and weakness in metabolic system are also some of the factors that increase the vulnerability of developing CCMs among elderly populations (Niccoli & Partridge, 2012).Controlling for age, females compared to males appear to be at greater risk of developing chronic conditions such as CVD, diabetes and hypertension (Garcia et al., 2016; Liu et al., 2017). Biomedical research shows that there is a difference in the gene expression in males and females. One of the reasons for the increased risk of the mentioned chronic conditions in women is because acute coronary syndromes are more prevalent in women than in men (Garcia et al., 2016). Additionally, there is evidence showing that genetic and lifestyle factors, including diet, have an influence on the incidence of chronic diseases, particularly, among females (Qi et al., 2014; Rappaport, 2016). Several studies have also found an association between place of residence and chronic disease risk factors (Jalali-Farahani et al., 2017; O'Connor & Wellenius, 2012). Research in South Africa shows a higher prevalence of chronic risk factors and diseases such as hypertension and diabetes in rural areas (40%) as compared to urban areas (34%) (Zyl et al., 2012). Low levels of income and educational attainment, as well as barriers to healthcare access, have been found to increase the risk of chronic diseases in rural and impoverished settings (Wang et al., 2014).

Statistics from South Africa show that NCDs account for over 60% of all deaths (STATS SA, 2017). To reduce these rates, more research is needed to prevent the development of chronic conditions. Research in South Africa has already shown that PLWH are faced with an increased risk of developing chronic diseases compared to the HIV negative population. Therefore, this study will not assess the risk of chronic conditions among the HIV positive or HIV negative population (Chhoun et al., 2017; Rodríguez-Arbolí et al., 2017). Rather, the aims to understand the dynamics of people living with HIV in South Africa.

1.2. Problem Statement

HIV CCMs are becoming common (Negin et al., 2012). Recent research shows that PLWH are faced with an increased risk of developing chronic diseases such as hypertension and diabetes (Chhoun et al., 2017; Rodríguez-Arbolí et al., 2017). Indeed, chronic diseases that are frequently reported by HIV infected persons in South Africa include hypertension and diabetes (Nlooto, 2017). However, comorbidities are not necessarily a result of an index disease. They may occur before or even after the diagnosis of an index disease (Gulbech Ording & Toft Sørensen, 2013). Data from the WHO posits that chronic conditions reported by PLWH may be pre-existing, HIV-related or even due to ageing (WHO, 2020a). This is supported by evidence from an epidemiological study that has shown that the HI virus and ARVs could interact with chronic disease risk factors that lead to the development of cardiovascular risk factors such as diabetes (Sarkar & Brown, 2000). Several other studies have cited the duration of HIV infection and longer use of ART as responsible for HIV CCMs Beery et al., 2018; Benzekri et at., 2018). Among these is clinical research which has shown that hypertension is associated with a CD4 cell count >200 cells/mm (Manner et al., 2013; Brennan et al., 2018).

The adult HIV prevalence in South Africa is 20.4% (UNAIDS, 2018) and over 70% of this population are on ART (AVERT, 2019a). This proportion of adults taking HIV treatment is expected to live longer and, therefore, at risk of developing additional chronic diseases. The difference in the risk of developing chronic diseases among HIV negative and PLWH is known. Findings from research in high income countries has shown that chronic disease behavioural risk factors such as smoking are higher in PLWH than in HIV negative persons (Petersen et al., 2014). In line with these findings, research conducted in South Africa also found that PLWH had an increased prevalence of overweight and obesity, compared to HIV negative persons (van Heerden et al., 2017). One study confirmed a chronic multi-morbidity prevalence of 4% among the South Africa adult population, the contributing risk factors were obesity and

smoking (Alaba & Chola, 2013). A prevalence of 77% and 17% for diabetes and hypertension was found among PLWH in South Africa, respectively (Oni et al., 2015b).

Understanding and preventing the dynamics of comorbidities is important because co-morbidities pose a serious public health concern. They are linked with an increased use and need of health services, decreased overall quality of life, and increased mortality (Kendir et al., 2018). While research shows that integrated care approaches applied within primary care settings can significantly reduce hospital admissions and mortality levels among patients with CCMs (Tortajada et al., 2017), the primary care system in South Africa continues to be challenged with issues such as the delivery of quality care (Maphumulo & Bhengu, 2019).

The financial and health costs of managing CCMs are an additional burden for patients, particularly those of low socio-economic status (Rosbach & Andersen, 2017). In low and middle-income countries, health systems are under immense pressure to expand their scope of services to deal with the increasing number of chronic diseases while managing the ongoing burden of HIV and Aids, and other infectious diseases (Rodriguez-Fernandez et al., 2016). The treatment and management of co-morbidities is difficult for both patients and health providers as they need costly prolonged treatment and care (Boutayeb et al., 2013). For health providers, the ComorbidityComorbidty comorbidty of diseases may be too complicated for simple treatment (Nobili et al., 2011). For example, patients with CCMs often require multiple treatment regimens that need to be prescribed and administered carefully to reduce the risk of drug interactions (Nobili et al., 2011). The treatment of HIV CCMs is of a major concern in South Africa because the country continues to be challenged by inefficient health systems. Like many countries, in 2011 South Africa adopted the Integrated Chronic Diseases Management (ICDM) modeI to address the double burden of HIV and Acquired Immunodeficiency Syndrome (AIDS) and non-communicable diseases.

HIV CCMs can be mitigated if detected early, through efforts to prevent the development of additional chronic conditions among PLWH as well as ensuring that health systems are accessible and adequately equipped to care for persons with HIV CCMs. In countries with high HIV prevalence, like South Africa, rapid and vast rollout of ART and Prevention of Mother to Child Transmission (PMTCT) has assisted in preventing many HIV related deaths, as well as mother-to-child-transmissions during birth and after. Even so, persons with HIV remain vulnerable to other chronic diseases or CCMs (Chhoun et al., 2017). While research has identified the levels and consequences of HIV CCMs (Arokiasamy et al., 2015; Oni et al., 2015b; Rosbach & Andersen, 2017), a few research gaps have been identified. These are: (1) the time taken before PLWH are diagnosed with a second chronic disease and (2) the

challenges regarding access to prevention, treatment, and management of CCMs faced by HIV positive adults living with CCMs in South Africa (Chhoun et al., 2017; Oni et al., 2015b).

1.3. Research Question

1.3.1. Main Question

What is the time to development, characteristics of, and challenges associated with additional chronic conditions (hypertension; diabetes; stroke; heart problems and cancer) among PLWH in South Africa?

1.3.2. Specific Research Questions

1. What is the time taken before HIV positive adults (18 - 75 years old) develop a second chronic condition in South Africa?
2. What are the demographic, socio-economic, and health-related characteristics associated with HIV positive adults (18 - 75 years old) developing a second chronic condition in South Africa?
3. What are the challenges regarding prevention, treatment and access to healthcare faced by adults (18 - 75 years old) with HIV chronic co-morbidities in South Africa?

1.4. Purpose Statement

The purpose of this study is to contribute towards reducing HIV CCMs in South Africa by assessing the time taken before adults living with HIV develop additional chronic conditions. Additionally, to understand the challenges adults with HIV CCMs face with regards to access to treatment, as well as the management of their comorbidities. This study is important for ensuring that chronic diseases in PLWH are detected early and affected persons are provided with adequate treatment and care to reduce morbidity. The study purpose is broken down into several research objectives shown in section 1.4 below. To achieve these objectives, this study made use of a mixed-method research design. The quantitative component of this research entailed secondary analysis of longitudinal data from the National Income Dynamics Survey (NIDS). The purpose of analysing secondary data was because the NIDS survey has collected nationally representative data on HIV and chronic diseases in South Africa from 2008

to 2017. The use of longitudinal data allows for event history analysis to determine the time (using age as the analysis time) taken before adults with HIV develop additional chronic conditions. The qualitative component of this research employed an exploratory phenomenological research method. The purpose of a phenomenological research method is to understand the experiences of individuals regarding a particular event or phenomenon (Helen & Susan Starks 2007). In this study, this method was used to understand the experiences and challenges regarding prevention; treatment and access to healthcare for adults living with HIV CCMs from the perspective of both diagnosed adults and their healthcare providers.

1.5. Research Objective

1.5.1. Main Objective

To determine the time to development, characteristics of, and challenges associated with additional chronic conditions (hypertension; diabetes; stroke; heart problems and cancer) among PLWH in South Africa.

1.5.2. Sub-Objectives

1. To show estimates of the prevalence of HIV CCMs among HIIV positive adults (18 - 75 years old) in South Africa.
2. To estimate the time before HIV positive adults (18 - 75 years old) develop a second chronic condition in South Africa.
3. To describe the demographic, socio-economic, and health-related characteristics associated with HIV positive adults (18 - 75 years old) developing a second chronic condition in South Africa.
4. To understand the challenges regarding prevention, treatment, and access to healthcare faced by adults (18 - 75 years old) with HIV chronic co-morbidities in South Africa.

1.6. Justification

In line with United Nations' Sustainable Development Goals (SDGs) Goal 3 (To ensure healthy lives and promote well-being for all at all ages), South Africa has committed to reduce premature mortality due to chronic diseases by one-third by the year 2030 (DOH & SANAC, 2013).

Both the time to HIV CCM diagnosis, as well as the health system challenges faced by persons living with HIV CCMs, are important areas of study in this research. This is because some of the objectives of the re-engineered primary healthcare model in South Africa are to increase life expectancy and strengthen the effectiveness of health systems (Bheekie & Bradely, 2016). As such, assessing the time taken before HIV CCMs occur is paramount and feeds into this model and the SDGs. Early identification and detection of HIV CCMs can ensure that interventions are initiated timeously, reducing morbidity and mortality related to HIV CCMs and improve the overall quality of life and the life expectancy of the HIV positive population (Bheekie & Bradely, 2016).

Several programmes in South Africa such as the National ART programme, the Test and Treat programme, project HOPE and the Chronic Disease Rehabilitation programme (CDRP) are working to address issues of chronic disease prevalence and mortality in the country (Beery et al., 2018; Project Hope South Africa, 2018; Sports & Science Institute of South Africa, 2017). The national ART programme aims to provide HIV testing and immediate treatment through ARVs to pregnant and breastfeeding women with HIV, as well as all patients that test HIV positive with CD4 ≤500 cells/mm (DOH, 2014). The Test and Treat programme aims to reduce HIV by providing treatment to all persons testing positive for HIV whether in need or not (Beery et al., 2018). Project HOPE is working to reduce chronic diseases in South Africa through, among others, health systems strengthening (Project Hope South Africa, 2018). CDRP, on the other hand, has the predominant goal of addressing chronic risk factors by providing therapeutic education and structured exercise programmes to patients. Chronic risk factors identified include physical inactivity, tobacco use, high cholesterol, poor diet, and stress through (Sports & Science Institute of South Africa, 2017). Despite the extensive investment in HIV and chronic disease programmes, several gaps exist in these HIV and chronic disease programmes. For example, while Project Hope is efficient in its strategy to reduce chronic diseases, it does not service all impoverished communities in South Africa (Project Hope South Africa, 2018). The CDRP is administered on payment and is, therefore, not always affordable, especially for poorer individuals with limited or no income. The national ART programme, as well as the Test and Treat programme, are not adequately run in some rural

areas. Major challenges include medicine stock-outs, insufficient nursing and service provider capacity and hospital pharmacies that are remote from their clinics. This creates difficulties in terms of access for patients, as well as for the delivery of medications (Gray et al., 2015).

There are evidently continued deficiencies in some of these programmes that hinder their ability to address HIV and chronic diseases, respectively. More importantly, and a concern to this study, is that these autonomous programmes do not address comorbidities. The programmes focus on either HIV or other NCDs, but not both (Zungu et al., 2019a). For example, there is no standardization within current NCD programmes to routinely test HIV positive persons for other chronic conditions (Zungu et al., 2019a). Like many countries, South Africa has adopted an ICDM that addresses the double burden of HIV/AIDS and NCDs (Department of Health, 2012). However, health systems continue to treat and respond to HIV and chronic diseases in silos. It has been found that in some health care sites the ICDM model adopted addresses chronic communicable diseases, such as HIV/AIDS, separately from NCDs (Asmal & Mahomed, 2016). As such, research has found that the health system is currently not adequately equipped to cater for persons with comorbidities (Nlooto, 2017). This study will therefore seek to better understand the challenges faced by persons living with HIV and receiving care in health facilities where the ICDM model is implemented to identify areas for strengthening within the model.

While primary HIV care is available and initiated in the South African public health systems, at times PLWH do not receive adequate care for HIV due to challenges to access, particularly in poor communities (Delobelle, 2013). The poor and elderly population are affected with issues such as health centres that are not within close proximity, absence of healthcare providers, as well as disrespectful healthcare workers (Annet, 2013). For undocumented foreign nationals in South Africa access is even more of a challenge. Healthcare providers sometimes state that they cannot provide treatment to these population groups due to limited state resources which prioritise South African nationals (Alfaro-Velcamp, 2017).

In addition, public health systems are overburdened with the treatment of both communicable diseases and non-communicable diseases (Delobelle, 2013). Weak and inaccessible health systems, especially for the poor, the elderly and foreign nationals, could become an even greater challenge if they are PLWH that want to prevent developing additional CCMs (Parekh & Barton, 2010). Some of the ways that the health system could be strengthened is through improving capacity and service delivery and ensuring that treatment is provided in accordance with the constitutional rights of all persons living in South Africa. Recent literature shows that, in South Africa, PLWH that are diagnosed with cardio metabolic conditions, such as

hypertension and diabetes, were less likely to progress along the continuum of care (Chang et al., 2019a). Providing an understanding of the challenges regarding treatment and access to healthcare for persons living with HIV CCMs is important. Public health policies and programmes need to be further informed on ways to strengthen the health system to particularly deal with comorbidities and ensure the health needs of PLWH CCMs in South Africa are catered for.

The significance of this study is three-fold. Chronic diseases may result in morbidity and premature mortality for adults. HIV CCMs can further increase this risk. For public health policy, it is firstly important to prevent the diagnosis of the second chronic condition among adults living with HIV to reduce premature morbidity and morbidity related to HIV CCMs and improve overall life expectancy for PLWH. Preventing illness and premature mortality due to any cause among adults is important as adults play a significant role in the social and economic development of the country, and the societies they live in. Illness and premature death for economically active adults leads to a reduction or complete loss of productivity in the workplace (Thakur et al., 2011). Beyond having a negative impact on economic growth, the consequences for illness due to CCMs among adults include overburdened health systems, increased medical costs for patients, and a decrease in overall quality of life (K. Kim et al., 2013). Within societies, adults (particularly women) are often caregivers to children and the elderly population (Sharma et al., 2016). Experiences of illness and premature death due to chronic diseases makes caregivers unable to fulfil these roles and, as a result, leave children and elderly people without care (Kidman & Thurman, 2014). For these reasons, it is important to keep them healthy and alive.

This study will further identify the characteristics that are associated with the time taken before PLWH develop a second chronic condition. This is important because it can inform NCD and HIV programmes about specific socio-demographic and economic factors that lead to HIV CCMs. This will assist them to tailor some initiatives to prevent and address CCMs, particularly among PLWH. This study can also assist existing programmes and policies to develop integrated HIV and NCD programmes that can ensure that all individuals testing positive for HIV are also routinely tested for other chronic illness and started on suitable chronic treatment immediately.

Conceptually, this study contributes to changing the way people think of diseases by showing that disease does not impact individuals in silos, and CCMs are becoming increasingly common among PLWH in South Africa (H. Lalkhen & Mash, 2015). Overall, this study is significant because there is public health interest in persons affected by HIV and chronic

diseases, respectively (Hofman, 2014; Serrano-Villar et al., 2016). As a result, there should be public health interest in persons affected by both diseases.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL AND CONCEPTUAL FRAMEWORKS

2.1. Literature Review

In this chapter, relevant literature on HIV CCMs is reviewed. The search was limited to PubMed and google scholar databases in order to identify studies on chronic diseases in PLWH. Additional searches on accredited websites such as those of the WHO, UNICEF and AVERT were also conducted to select published reports, proceedings, and updates on HIV CCMs. The search terms used were Comorbidity; chronic conditions; chronic diseases; HIV chronic comorbidities; chronic comorbidities; PLWH and chronic conditions; HIV and hypertension; HIV and cardiovascular disease; HIV and stroke; HIV; HIV and cancer as well as HIV and diabetes. Only studies and reports published in English were selected.

The chapter is divided into three sections. In the first section, provides a global overview of literature on HIV CCMs. This is followed by a review of studies from sub-Saharan Africa, and then South Africa. The literature discusses the growing prevalence of HIV CCMs, the association between HIV and several chronic conditions, and assesses studies on the time taken before PLWH develop comorbidities.

In the second section, the three theoretical frameworks to which this study is grounded are discussed. This chapter further takes the reader through the conceptual framework developed to guide the assumptions made in this study. The conceptual framework is based on the literature reviewed, theoretical framework, and the research gaps that this thesis aims to fill. After providing a critical review of literature, the research hypotheses that are tested are included in the final section of this chapter. Given that the study is based in South Africa, a matrix of some of the key literature on the prevalence of HIV CCMs and the association between HIV and chronic conditions in South Africa is also provided.

2.1.1. Global Overview

2.1.1.1. Prevalence of HIV CCMs

HIV was first identified in the late 1950s and has since been subject to scientific research and debate (AVERT, 2019b). Global statistics on HIV report that the incidence of HIV has declined by 16% between 2010 and 2017 (Global HIV & AIDS Statistics — 2018 Fact Sheet | UNAIDS, n.d.). However, the number of people living with HIV remains high (36.9 million).

With the advancement in, and increasing access to, ART this population group is expected to live longer (Wandeler et al., 2016). Evidence indicating an increased life expectancy among PLWH because of ART is widely available. Findings from the HIV Prevention Trials Network (HPTN) 052 study have shown the efficacy of ART in reducing transmissions (Cohen et al., 2011). In the TEMPRANO and START studies early ART treatment initiation was significantly associated with a reduction in the risk of serious clinical conditions, the development of AIDS, and mortality (Gelpi et al., 2018).

Unfortunately, increased life expectancy among PLWH presents new challenges (Chhoun et al., 2017). Some of these challenges include the development of chronic diseases in PLWH. Globally the most prevalent chronic diseases are CVDs (heart disease and strokes), cancer, chronic obstructive pulmonary disease (COPD), and diabetes (WHO, 2018b). In 2005, there were over 422.7 million reported cases of CVD worldwide (Roth et al., 2017). About 85% of these cases are attributable to heart disease and strokes (Roth et al., 2017). Over 32.6 million people worldwide have been estimated to be living with cancer and, in 2016, a global prevalence of 251 million cases of COPD was reported (Khazaei et al., 2015; Mathers & Loncar, 2006). In addition, the global prevalence of diabetes has risen from 5% in the 1980s to 9% in 2014 (Mathers & Loncar, 2006).

An array of research has cited a high prevalence of HIV CCMs. In the US, a 65% CCM prevalence was observed among patients with HIV (D. J. Kim et al., 2012). In a community based study in the UK 29% of PLWH had a CCM (Lorenc et al., 2014). A study in Brazil confirmed that CCMs are higher in HIV positive patients compared to HIV negative patients (Maciel et al., 2018b). In these studies, common CCMs include dyslipidaemia, COPD, CVDs, as well as metabolic conditions such as diabetes and hypertension (D. J. Kim et al., 2012; Lorenc et al., 2014). Corroborating these findings are several other studies that have confirmed an increased risk of COPD, hypertension, diabetes, cancer, stroke, lung and CVD among PLWH (Friedman & Duffus, 2016; Gelpi et al., 2018; Mayer et al., 2018; Noubiap et al., 2019). For example, findings from the Brazilian HIV Cohort Study reported that among

PLWH, almost 10% were diagnosed with a CVD (Maciel et al., 2018b). A clinic based study in the US found that among HIV infected patients, 40% had hypertension, 12% were diagnosed with COPD, and 9% had diabetes (D. J. Kim et al., 2012). In a study conducted in Japan, almost 70% of PLWV were diagnosed with at least one chronic condition including, among others, hypertension and diabetes (Ruzicka et al., 2018). While hypertension seems to be commonly reported among PLWH, some evidence has shown a decreased risk of hypertension in its HIV positive sample (Gelpi et al., 2018). In one study traditional risk factors of hypertension, such as age, gender and behavioural characteristics (smoking, diet etc.), all played a role in the decreased prevalence of hypertension that was observed in HIV positive patients (Fahme et al., 2018).

One study conducted in Cambodia showed that while the individual prevalence of diabetes (9%) and hypertension (15%) among PLWH were high, there was very low prevalence (1%) of HIV infected patients that had both diseases (Chhoun et al., 2017). According to this study, being diagnosed with three or more chronic conditions was also uncommon (Chhoun et al., 2017). Nonetheless, according to the WHO, all this research suggests an increasing global awareness of the gravity of CCMs in PLWH (WHO, 2020b).

2.1.1.2. Association between HIV, ART, and Chronic Diseases

The association between HIV and some of the aforementioned chronic diseases has been extensively researched, and yet is not fully understood (Yang et al., 2019a). However, the possible relationship can be explained as two-fold. Firstly, some studies show that HIV infection leads to a disruption of the body's natural mucosal system and the passage of microbes into the system circulation, resulting in chronic conditions such as hypertension (Fahme et al., 2018). The emphasis on hypertension is because it serves as a risk factor for other chronic conditions, such as CVD. Supporting the inflammatory nature of the virus is another large body of research that has found an association between inflammatory markers of HIV-related chronic immune activation and hypertension (Bautista et al., 2005; Fahme et al., 2018). This immune activation and inflammation caused by the virus has also directly been linked with an increased risk of CVD in PLWH (Conklin & Pineda, 2017). For example, in an analysis of large healthcare database Alonso et al (2019) reported an increased risk of heart failure and stroke among PLWH. However, some studies argue that the risk of stroke in PLWH is associated with a low CD4 count and uncontrolled viral load (Marcus et al., 2014; Serrano-Villar et al., 2016).

Further research conducted to understand the mechanisms in which HIV increases the risk of, at least some, chronic diseases have pointed to the influence of ART (Yang et al., 2019a).

A longitudinal study following a cohort of HIV positive men found that hypertension was significantly increased among men who recently started ART (Seaberg et al., 2005). A substantial amount of epidemiological research has shown that Metabolic Syndrome (MS) is one of the side-effects of ART (Yang et al., 2019a). MS is defined as a group of components such as hypertension, excessive body fat and abnormal cholesterol that are associated with an increased risk of CVD and diabetes (Naidu et al., 2017). Earlier studies have reported the prevalence of MS in PLWH ranges between 11% and 26% (Magny Bergersen et al., 2006; Samaras et al., 2007). Factors associated with MS have also included older age, female sex, and a high BMI (Osoti et al., 2018a).

Barbaro et al (2009) presented evidence that ART regimens containing protease inhibitors (PIs) caused metabolic change in PLWH (Barbaro & Iacobellis, 2009). Similarly, a systematic review by Echecopar-Sabogal et al (2017) found that use of PIs was associated with MS. However, in this study, there was no association between PIs and the development of diabetes (Echecopar-Sabogal et al., 2018). Therefore, the increased risk of chronic conditions such hypertension, stroke, and CVD can be as a result of MS resulting, especially, from long term exposure to ART (Wand et al., 2007). However, evidence on the risk of MS or hypertension in ART compliant and ART naïve persons differ. For example, one study suggested that MS in ART compliant and ART naïve patients did not differ (Osoti et al., 2018a). In another study, hypertension was found to be higher (28.7%) among ART treated patients compared to ART naïve controls (Masenga et al., 2019). While ART is associated with MS, leading to the development of chronic conditions including hypertension, the risk of not using ART can result in adverse morbidity and mortality (Paula et al., 2013). In addition, newer drugs including the integrase inhibitors are reported to be associated with a lesser cardiovascular risk (Wing, 2017).

Other chronic conditions, namely, obstructive lung disease and cancer in some HIV positive persons have also been linked to long-term inflammation caused by the HI virus (Deeks, Tracy, et al., 2013). Some research found that HIV positive persons on ART had higher inflammatory markers compared to HIV negative patients (Siedner et al., 2016). It is evident that both HIV and ART can trigger the inflammatory response (Masuku et al., 2019). From this body of knowledge, it is becoming clearer that HIV, both directly and indirectly, leads to the activation of some chronic diseases (Deeks, Tracy, et al., 2013).

2.1.1.3. Time before PLWH develop CCMs

In the absence of ART, persons whose HIV progresses to AIDS generally experience AIDS-related complication or death within 2-3 years (Dau & Holodniy, 2008). On the other hand,

some studies have demonstrated that the duration of HIV infection and ART is associated with the onset of chronic conditions such as hypertension (Baekken et al., 2008; Fiseha et al., 2019; Manner et al., 2012). Even so, one study confirmed that comorbidities appear to be largely independent of HIV duration (Arokiasamy et al. 2015). The scarcity of literature on the time factor makes it unclear exactly how long it takes persons diagnosed with HIV and on ART to develop either hypertension, diabetes, CVD, or any other of the chronic conditions. Research conducted in Canada that followed a cohort of HIV positive adults over a six year period found that at least 24% of participants became hypertensive for the first time within that period (Okeke et al., 2016). In several studies, MS were found to develop within three years of ART initiation (Dau & Holodniy, 2008; Wand et al., 2007). In a three year follow up of a group of HIV positive adults using protease inhibitors almost 8% presented with diabetes (Salehian et al., 2005). However, the study by Dau et al (2008) confirmed that cardiovascular effects in PLWH may take months to years to develop after the start of ART (Dau & Holodniy, 2008).

2.1.2. Sub-Saharan Africa (SSA) Overview

2.1.2.1. Prevalence and risk of HIV CCMs

The burden of HIV is highest in the SSA region with over 25 million PLWH in 2018 (WHO, 2018c). Studies in SSA have found an increased risk of some chronic diseases among PLWH (Hyle et al., 2017; Negin et al., 2012). Research specifically on diabetes in SSA show that up to 26% of PLWH are diagnosed with diabetes (Njuguna et al., 2018). However, one study in Cameroon found a low prevalence of diabetes among HIV positive (Noumegni et al., 2017). In line with the findings observed in SSA (Naidu et al., 2017), a systematic review of studies conducted in 20 developing countries found that over 30% of PLWH had cardiovascular complications (Haregu et al., 2012). Hypertension is a risk factor for both CVD and diabetes and is common among PLWHV (Lucero et al., 2014; Van Remoortel et al., 2013). The prevalence of hypertension among PLWH in low and middle income countries is estimated to range between 8.7% and 45.9% (Todowede & Sartorius, 2017).

While the focus of this current research is on persons diagnosed with HIV and not so much on those living without HIV, it is important to say that PLWH and HIV negative people who have a family history of chronic conditions and who engage in chronic risk factors - such as smoking, alcohol use, physical inactivity, and poor diet – have an increased risk of developing hypertension and other cardiovascular diseases. However, several studies have shown that

PLWH have a higher prevalence of chronic conditions such as diabetes, hypertension, and stroke compared to their HIV negative counterparts (Yang et al., 2019a). This is possibly because beyond biological effects and/or individual behaviours, characteristics of the HI virus, and some ART regimens the risk of chronic conditions among HIV diagnosed persons (Maseko & Masuku, 2017).

While several limitations continue to exist with the delivery of the ICDM and the adoption of similar models in other African contexts, the model outlines that PLWH should routinely be screened and assessed for common chronic conditions such as hypertension during their ART clinic visits (DOH & SANAC, 2013). This provides opportunity for early diagnosis of chronic conditions which their HIV negative counterparts would not otherwise be exposed to because of irregular visits to a health facility.

In a hospital based study in Zimbabwe, approximately 16% of PLWH were diagnosed with a second chronic condition in addition to HIV (Magodoro et al., 2016). In this study, hypertension, asthma and diabetes were among the prevalent types of CCMs (Magodoro et al., 2016). However, research on the risk of hypertension in PLWH in SSA is diverse. For example, a longitudinal study of HIV care in a Tanzanian hospital found a 10% risk for PLWH in the study to develop hypertension (Rodríguez-Arbolí et al., 2017). Another hospital-based study in Ethiopia found that over 50% of its HIV positive sample reported an additional chronic condition from hypertension, diabetes, CVD, COPD, and cancer (Woldesemayat, 2020). Contrary to these findings was a systematic review of countries in SSA which found a low prevalence of high blood pressure in PLWH in SSA (Dillon et al., 2013). Nonetheless, at an aggregate level, HIV CCMs in SSA is on the rise. In countries such as Zimbabwe, CCMs among PLWH are projected to increase by 26% by the year 2035 (Smit et al., 2018).

A systematic review of literature on HIV and CVD in SSA found an elevated risk of CVD among PLWH, especially where CVD risk factors are prevalent (Dimala et al., 2018a). In a cross-sectional study of patients on HAART in Nigeria, researchers found an increased risk of CVD among PLWH in SSA. This study argued that the elevated risk could be owed to the growing risk of hypertension among adults infected with HIV as hypertension is among the risk factors for CVD (Dimala et al., 2018a). Another systematic review of metabolic diseases among PLWH in SSA found an excess risk of cerebrovascular diseases such as stroke among HIV infected adults (Watkins et al., 2016). These observations are confirmed by results from another systematic review on HIV and CVD that found that PLWH had an elevated risk of stroke (Hyle et al., 2017). However, a case control study in Malawi found that while HIV was

significantly associated with stroke, the presence of hypertension was not a mediating factor for stroke (Benjamin et al., 2016).

COPD and cancer are some of the other chronic conditions reported by PLWH in SSA. An analysis of data from Uganda found hypertension (30.5%) and COPD (7.3%) among their sample of PLWH (Okello et al., 2015). A case control study in Cameroon also found a significant association between HIV and COPD (Pefura-Yone et al., 2015). In this study, the prevalence of COPD was 2.2% among PLWH compared to 0.7% in their HIV negative counterparts (Pefura-Yone et al., 2015). Tobacco use is a common risk factor for COPD (Lalloo et al., 2016). However, in SSA countries such as Cameroon where smoking prevalence is low, increased risk of COPD among PLWH was reported to be as a result of factors such as past history of respiratory infections, including TB, and low BMI (Lalloo et al., 2016; Pefura-Yone et al., 2015). With regards to cancer, HIV is significantly associated with cancer, even in SSA (Magodoro et al., 2016). However, the association between HIV and lung cancer has been contested by an earlier study in South Africa (Sitas et al., 2000). A recent study conducted in Cote d'Ivoire found that PLWH were two times more likely to develop liver cancer (Tanon et al., 2012). In contrast, evidence from a study in Uganda suggested a low risk of liver cancer among PLWH in SSA, which could be because of under diagnosis and short duration of HIV diagnosis (Sasco et al., 2010).

Findings from an institutional paper based on a retrospective study of medical records from a hospital in Kenya found a CCM prevalence of almost 40% among PLWH (Munoko, 2014). The leading types of CCMs in this study included hypertension, diabetes, chronic kidney disease, dyslipidaemia, stroke. and CVD (Munoko, 2014). Further confirming that HIV CCMs are increasingly common in sub-Saharan Africa is a systematic review on diabetes in HIV positive patients that found that incidence ranged from 5% to 60% (Prioreschi et al., 2017).

Generally, from observing these studies, the most common chronic conditions reported by PLWH in sub-Saharan Africa are like the reports in more developed countries and include hypertension, diabetes, cardiovascular conditions, cancer, and COPD. However, a recent scoping review by Gonah et al (2020) has found inconsistent HIV CCM prevalence data across the sub-Saharan region (Gonah et al., 2020). In this review, while a hypertension prevalence of about 10% was reported in PLWH across three studies, this rate was significantly lower compared to countries like the US and Italy (Gonah et al., 2020). Again, while the diabetes prevalence in PLWH in Malawi and Zimbabwe ranged between 1% - 13%, studies conducted outside of Africa reported higher prevalence (Gonah et al., 2020). The lower prevalence of

HIV CCMs in sub-Saharan Africa could be an indication of smaller sample sizes used in African studies compared to research conducted in more developed countries.

2.1.2.2. Association between HIV, ART, and Chronic Diseases

While research shows that HIV CCMs are becoming common in SSA, there is limited and conflicting results on the time taken before HIV infected adults and those on ART develop the second chronic condition. For example, a hospital-based study in Ethiopia found that patients on ART for at least six years had an increased risk of developing an additional chronic condition, with hypertension being the most common chronic condition (Gebrie, 2020). In another study conducted in Cameroon, 61% of HIV infected patients that were on ART for no less than 34 months developed CVD risk factors such as hypertension (Dimala et al., 2018a).

Few studies have explored the mechanism in which HIV is associated with some of the described chronic conditions among populations in SSA. The nature in which the HI virus is associated with chronic diseases is expected to be different from what has been reported in developed countries. One of the reasons is because some evidence has suggested a difference in the cardio metabolic risk profile of people in SSA, compared to those from first world countries such as those in Europe (Goedecke et al., 2010; Schuster et al., 2007). Studies in this line of argument postulate that populations in the SSA have lower drinking and alcohol consumptions rates compared to populations of European decent (Dillon et al., 2013). Interestingly, a systematic review of metabolic syndromes among PLWH in SSA found that the average prevalence of MS is 30.5%, a percentage that is significantly higher than that found in Asia (21.5%) and South America (21.4%) (Todowede & Sartorius, 2017).

In line with the array of research by Barbaro et al (2009); Echecopar-Sabogal et al (2017), and Alonso et al (2019), a study in Swaziland confirmed that hypertension in PLWH is triggered by various mechanisms such as changes in BMI, characteristics of the HI virus, and some ART regimens (Maseko & Masuku, 2017). The effects of ART on the development of chronic conditions cannot be ignored irrespective of the low prevalence of tobacco or alcohol that may be present in SSA. For example, a systematic review of over 40 000 HIV infected participants by Nduka et al (2015) presented evidence that irrespective of socio-demographic differences among populations, exposure to ART was significantly associated with increased risk of hypertension (Nduka et al., 2016). Similarly, a study in Ethiopia found an increased risk of HIV CCMs among patients on ART (Getahun et al., 2020). In this study, almost 20% of patients on ART had either hypertension or diabetes and factors associated with these HIV comorbidities included taking the ART containing tenofovir (Getahun et al., 2020). These findings were contested in a systematic review of 20 cross-sectional studies, which reported

that while ART was associated with dyslipidaemia, there was no association between ART and hypertension or diabetes (Dimala et al., 2018b).

One study also suggested that HIV was significantly associated with insulin resistance which is associated with diabetes and cardiovascular complications (Noumegni et al., 2017). Similar to the global literature reviewed, risk of chronic conditions in PLWH in the SSA regions has been associated with HIV infection, ART, and the prevalence of other metabolic conditions such as hyperlipidaemia, hypertension, and diabetes (Watkins et al., 2016).

2.1.2.3. Factors associated with CCM in PLWH

The demographic and socio-economic factors associated with chronic diseases, including HIV and Aids, have been widely studied in SSA. These include age, sex, geographical location, ethnicity, marital status, as well as level of income and education (Saeed et al., 2013; Steenkamp et al., 2014). Some studies have observed that health risk behaviours and some of these demographic and socio-economic factors influence the development of CCMs among PLWH in SSA. A systematic review of the factors associated with dysglycemia among PLWH reported that an increased BMI, older age, and the male gender are independently associated with diabetes among PLWH (Njuguna et al., 2018). Each of these demographic and socio-economic factors are discussed independently.

***Age*:** Older age has been associated with the development of chronic illnesses. Several studies have found that older PLWH are more likely to have chronic conditions compared to HIV negative persons (Balderson et al., 2013; Wing, 2017). Evidence shows that physical functioning in older PLWH deteriorates faster compared to older persons without HIV (Oursler et al., 2011). Also as alluded to earlier, chronic conditions among PLWH are exacerbated by the HIV infection and/or long term exposure to ART (Yang et al., 2019b). Some of the common CCMs in the older age PLWH include hypertension and diabetes (Ruzicka et al., 2018). For example, a cross-sectional study in Zimbabwe found that the risk of hypertension is higher for HIV positive adults aged over 40 years old (Chireshe et al., 2019). However, Benzekri et al (2018) reported that older age is a predictor for hypertension in PLWH as with HIV negative persons (Benzekri et al., 2018). A few other examples of the increased risk of chronic conditions as PLWH grow older include a study conducted in Ethiopia which found that the risk of developing HIV CCMs was eight times higher between the ages of 35 and 54 years (Getahun et al., 2020). A cross sectional study in Nigeria reported an increased risk of COPD among PLWH aged 50 years and older compared to adults aged between 30 and 40 years old (Akanbi et al., 2015). Another study in South Africa found that the risk for obstructive lung disease among PLWH increases as a person ages (Gupte et al., 2017).

***Sex*:** Overall, women are disproportionally affected by HIV, particularly in sub-Saharan Africa (Sia et al., 2016). Findings reported by Mugisha et al (2016) found that older women living with HIV had higher odds of having one or more chronic conditions (Mugisha et al., 2016). The increased risk of chronic conditions in HIV positive women could be because of the increased risk of HIV among women to begin with. However, there is evidence from the SSA region showing that MS is more prevalent in females than in males (Todowede & Sartorius, 2017). Even so, in a hospital based study in Ethiopia, while elderly age was significantly associated with chronic conditions in HIV positive patients, no significant difference was observed by sex (Woldesemayat, 2020). There seems to be a difference in chronic risk behaviours between males and females. For example, a study in South Africa found that while males were less likely to have a high waist circumference, they had a higher prevalence of smoking (10.8%) and alcohol use (39.1%). Several studies have found an association between tobacco and alcohol use and CVD, COPD, and stroke even among PLWH (Egbe et al., 2019; Shuter et al., 2014). In fact, a smoking prevalence of up to 24% has been reported in males living with HIV (Mdege et al., 2017). Indeed a descriptive study in Zimbabwe found that over a third of males living with HIV had hypertension, which was slightly higher than amongst females (28.1%) (Chireshe et al., 2019). Therefore, the chronic risk behaviours in both men and women could be placing them at greater risk of chronic conditions.

***Place of residence*:** Generally, chronic conditions are common in people living in rural areas (Louie & Ward, 2011). However, there has been conflicting findings on whether the risk of HIV CCMs varies across geographical areas. Some research from South Africa has found an increased prevalence of hypertension among PLWH in urban areas (Hopkins et al., 2019). In addition, chronic precursors such as obesity and high blood pressure in PLWH have been reported to be higher in urban populations (Hopkins et al., 2019; HSRC, 2005). Other chronic risk factors such as BMI have been studied. However, in a large population-based survey conducted in South Africa, BMI was not associated with place of residence (Malaza et al., 2012). This was confirmed in the study by Chireshe et al (2019) which found that place of residence was not associated with chronic conditions such as hypertension in PLWH (Chireshe et al., 2019). Even so, as the gross domestic product (GDP) in low-income countries increases, populations in rural areas, including the HIV positive, are steadily experiencing the burden of chronic risk factors such as obesity and high blood pressure (Malaza et al., 2012). As such, the effect of place of residence on chronic conditions should continue to be studied.

***Socio-economic status - employment status, level of income and education*:** Some research has pointed out that chronic conditions disproportionally affect people of a low socio-economic status (Adler & Ostrove, 1999; Louie & Ward, 2011). A systematic review on

inequalities in NCDs found that low socio-economic status was associated with an increased risk of chronic conditions including CVD, diabetes, cancer, and COPD (Sommer et al., 2015). Another study found that PLWH were more likely to earn less compared to their HIV negative counterparts (Yang et al., 2019b). In this study, the average monthly household income was less than R750 or US$50 (Yang et al., 2019b). Not all studies agreed with respect to level of income serving as a predictor factor for HIV CCMs. For example, in the study by Chireshe et al (2019), level of income was not associated with hypertension in PLWH (Chireshe et al., 2019). This was found true by a cross sectional study on HIV comorbidities in South Africa reporting that income was not significantly associated with HIV comorbidities (Nlooto, 2017). Instead, another study suggested that income inequality is likely to have an impact on chronic risk factors (Sliwa et al., 2016). Data from the World Health Survey has showed that people with lower levels of education had an increased prevalence of comorbidities (Hosseinpoor et al., 2012). This was similar for HIV infection as evidenced in another study showing that the risk of HIV was higher among participants who were less educated compared to those with tertiary education (Tlou, 2019). Higher education attainment also often leads to better employment prospects. Employment is critical in ensuring that PLWH alike have income and can maintain their standard of living. However, it is worth noting that employment status as a variable is not an accurate measure of socio-economic status because it does not necessarily reflect an individual's financial status (Daya et al., 2016).

***Race*:** Studies from SSA have found that the risk of HIV is significantly higher among Black Africans compared to other races (M. Mabaso et al., 2019). However, it seems as though there is a difference in the chronic risk factors and conditions experienced by different racial groups. One study showed that the prevalence of hypertension was elevated among black Africans compared to other ethnic groups (Hopkins et al., 2019). In another study, the prevalence of CVD was higher among white males compared to other racial groups (Lorenc et al., 2014). Black Africans also experience chronic conditions such as CVD and there have been several studies that have shown CVD risk factors, such as hypertension, are more common in black Africans (Kurian & Cardarelli, 2007; Winkleby et al., 1998). When it comes to comorbidities, some research showed that white males were more likely to have comorbidities (Lorenc et al., 2014). This is the inverse of what has been found in developed countries suggesting, for instance, no difference in the incidence of MS in PLWH by ethnicity (Wand et al., 2007). The paucity of literature on the dynamics of HIV CCMs in the SSA justifies the need for further research on the impact of race or ethnicity on the development of HIV CCMs and the difference in Comorbidity disease management across different ethnic or racial groups.

***Marital status*:** The odds of HIV has been reported to be lower among married persons compared to other relationship groups (Shisana et al., 2016). Where other chronic conditions are concerned, one study found that widowed participants were more than two-folds more likely to be hypertensive than participants who were married (Mathebula et al., 2020). However, this could be because of stress which has been closely associated with hypertension. The loss of a partner could increase stress levels and result in hypertension. Irrespective of death of a partner, a study conducted in Ghana by Tuoyire & Ayetey (2018), also found higher odds of hypertension among married, cohabiting, and women who had been married previously (Tuoyire & Ayetey, 2019). Interestingly, this study did not observe the same findings for men (Tuoyire & Ayetey, 2019). Other than these studies, most studies across Tunisia, Kenya, and South Africa that have assessed the relationship between marital status have found no significant association between the two (Hammami et al., 2011; Macia et al., 2012; Peltzer & Phaswana-Mafuya, 2013). However, these studies did not assess the effect of marital status on other chronic conditions or on comorbidities. Even so, it is worth noting that in some studies, being unmarried was significantly associated with poorer outcomes of quality of life (Biraguma et al., 2018).

***Religion*:** In most studies, religion has had an effect on HIV prevention and, in some, perpetuating HIV related stigma and discrimination (Ochillo et al., 2017; Zou et al., 2009). A review of faith-based organisations in Africa noted that churches had an influence on individual perceptions of chronic risk factors, such as alcohol use. However, it also noted that they needed to play a greater role in promoting other HIV prevention mechanisms, such as women empowerment and tackling issues of sexuality (Mash & Mash, 2013). Other than this, the influence of religion on the development and management of HIV CCMs has not been widely studied.

***Chronic disease risk factors*:** Chronic risk factors such as unhealthy diets (high intake of fat, salt, and refined sugars), physical inactivity, tobacco, and alcohol use are common among PLWH (Oni et al., 2015b). Smoking and alcohol use have been associated with the development of several chronic conditions among PLWH, including cancers and lung disease (Lorenc et al., 2014). A recent study from South Africa by Kamkuemah et al (2020) found that more than three quarters of the HIV positive adolescents who participated in the study were obese and there was a high prevalence of smoking, alcohol use, and poor diet (Kamkuemah et al., 2020). In Tanzania and Uganda, smoking prevalence ranged between 1% and 23% among both men and women (Kavishe et al., 2015). In this study, smoking and alcohol use were significantly associated with hypertension - which itself is a risk factor of other CVDs (Kavishe et al., 2015; Woldesemayat, 2020). In the study conducted by Zenebework et al

(2020) in Ethiopia, a BMI ≥ 25 was associated with an increased risk of chronic diseases in PLWH (Getahun et al., 2020). A high BMI can be caused by several factors including lack of exercise and an unhealthy diet. Nonetheless, and as alluded earlier, factors such as an increase in age, chronic immune activation, HIV infection, and the use of some ART can also jointly and independently be responsible for the growing risk of chronic diseases in PLWH (Hemkens & Bucher, 2014).

2.1.3. Country Overview: South Africa

2.1.3.1. Risk of developing HIV by demographic characteristics

The risk of developing HIV by different demographic characteristics has been well documented. In South Africa, women and particularly adolescent girls and young women (AGYWs) are at increased risk of HIV infection compared to their male counterparts (AVERT, 2019a). In 2018, an estimated 4.7million women in the country were living with HIV compared to only 2.8million men while in the same year almost 70 000 AGYWs became infected with HIV compared to 28000 young men (AVERT, 2019a).

Socio-economic status is an important factor that is further related to HIV infection. Research in South Africa found the prevalence of HIV to be highest among the poor (20.8%) compared to persons with an upper socio-economic status. In addition, the prevalence of HIV was significantly higher among black Africans (20.2%) compared to other races (Wabiri & Taffa., 2013). Reasons adduced include increase in transactional sex and the expansion of sexual networks. The inverse relationship has also been observed by several studies whereby the socio-economic impact of HIV/AIDS has led to HIV becoming strongly associated with poverty (UNIADS 2004; Gonzalez et al., 2012). Furthermore, Saeed and Steenkamp 2013 found that, sex, geographical location, ethnicity, marital status, as well as level of income and education had an association with the development of other chronic conditions including hypertension (Saeed et al., 2013; Steenkamp et al., 2014).

2.1.3.2. Prevalence of HIV CCMs

The prevalence of chronic conditions among PLWH in South Africa has ranged between 20% and 60% in most studies. Findings from the WHO's Study of Global Aging (SAGE) in South Africa reported that almost 30% of HIV infected adults aged 50 years and above had ComorbidityComorbidty comorbidty (Negin et al., 2012). Similarly, an institutional paper that

provided a prospective analysis of CCM patterns in a primary health care clinic in Cape Town found a Comorbidity prevalence of 22% (Oni et al., 2015b). The comorbidities assessed in this study were HIV, hypertension, diabetes, and TB (Oni et al., 2015b). At the community level, a study in KwaZulu-Natal found that about 56% of its study participants had CCMs (van Heerden et al., 2017). In this study, common CCMs were HIV, hypertension, depression, and hyperlipemia (van Heerden et al., 2017). In another study assessing the chronic diseases among HIV positive educators, almost 40% reported living with an additional chronic condition in addition to HIV (Zungu et al., 2019a). Several other studies have reported a high prevalence of CCMs among PLWH in South Africa. For example, a health survey conducted in rural KwaZulu-Natal found a 28% prevalence rate of hypertension among PLWH (Malaza et al., 2012). A community based survey in Cape Town also reported a high prevalence (21.6%) of dysglycaemia among PLWH (Levitt et al., 2016).

2.1.3.3. Double burden of HIV and Chronic Diseases

Countries in SSA face a double burden of HIV/AIDS and noncommunicable diseases including hypertension, diabetes, stroke and cancers. South Africa in particular, not only has the highest HIV profile in the world with 8 million HIV positive adults as of 2019 but almost 45% of South Africans have hypertension (SADHS, 2016). Important to note is that hypertension constitutes the foundation for the CVD epidemic in SSA (Peer 2015). Modjadji 2021 made emphasis on the point that the double burden phenomenon of HIV and chronic diseases is of major public health concern as the management of multimorbidity is complex to treat and challenging for patients to manage (Modjadji 2021).

Recent research in South Africa has shown that possible reductions in the probability of suffering from chronic conditions in the presence of HIV include exercise; maintaining a healthy diet and avoiding chronic risk behaviours such as tobacco and alcohol use (Godongwana et. al 2021). Good health seeking behaviour plays an important role to timeously detect chronic conditions and initiate treatment.

2.1.3.4. Association between HIV, ART, and Chronic Diseases

There is an ongoing debate about the association between HIV and various chronic diseases in South Africa. In contrast to findings from High Income Countries and some studies in SSA (Hyle et al., 2017; Negin et al., 2012), an analysis of the SAGE study in South Africa found no significant association between HIV and a number of chronic diseases such as hypertension, stroke, diabetes and depression among adults aged 50 years and older (Negin et al., 2012). Some of the limitations of the SAGE study is that it did not assess the length of HIV diagnosis

and the association between ART and chronic diseases (Negin et al., 2012). The study by Malaza et al. (2012 found that hypertension was significantly associated with both HIV and ART (Malaza et al., 2012). The increasing prevalence of dysglycaemia in the community survey by Levitt et al. (2016) was also found to be associated with HAART, such as protease inhibitor therapy (Levitt et al., 2016). With regards to dyslipidaemia which increases the risk of CVDs, a cross sectional study reported an increased risk of dyslipidaemia among HIV positive black South Africans (Fourie et al., 2011). A new prospective study, known as the Ndlovu Cohort study, has been launched to profile the risk of CVD among PLWH in South Africa (Vos et al., 2017). Preliminary results in this study show that CVD risk is not associated with either HIV or ART (Vos et al., 2017). Of the studies that have examined the association between HIV and diabetes in SSA, the majority have been conducted in South Africa (Hoosain Lalkhen & Mash, 2015; Sharman & Bachmann, 2019). In these studies, adults infected with HIV faced an increased risk of developing diabetes. A summary of other relevant studies on HIV CCMs in South Africa is provided below.

Table 1.1: Literature Review Matrix of HIV CCM studies in South Africa

Citation & Year	Title	Study Design	Study size (n)	Results/Findings	Gaps
Negin et al (2012).	Prevalence of HIV and chronic comorbidities among older adults	Cross sectional analysis of the WHO's Study of global Ageing and adult health (SAGE) survey conducted in South Africa in 2007–2008.	4227	Approximately 30% of PLWH had two or more chronic conditions; age and sex were associated with chronic conditions among younger PLWH but not among those older than 50 years.	SAGE survey did not consider duration of HIV infection and time on ART.
Lalkhen & Mash (2015) (Hoosain Lalkhen & Mash, 2015).	Multimorbidity in non-communicable diseases in South African primary healthcare	Cross sectional analysis of morbidity survey of SA's Primary Healthcare Facilities (PHC).	18 856	Only 1.1% of participants with NCDs had HIV; however, Comorbidity of chronic conditions was high (65%) and associated with older age; hypertension was the most common comorbid condition.	Study was limited to patients attended PHC; could explain low prevalence of HIV CCM.
Chang et al (2018) (Chang et al., 2019b).	Multimorbidity and care for hypertension, diabetes and HIV among older adults in rural South Africa	Analysis of cross-sectional data from patients enrolled in the Health and Aging in Africa: a Longitudinal Study of an INDEPTH Community in South Africa.	5059	Over 70% of HIV infected participants had cardio metabolic conditions and were more likely to present with hypertension or diabetes.	The time sequencing of the chronic conditions was not assessed. Causality could also not be determined because of the cross-sectional nature of this study.
Sharman & Bachmann (2019) (Sharman & Bachmann, 2019).	Prevalence and health effects of communicable and non-communicable disease Comorbidity in rural KwaZulu-Natal, South Africa	Analysis of longitudinal population-based HIV and health surveillance study in rural KwaZulu-Natal, South Africa.	47 334	Chronic comorbidities in PLWH increase with an increase in age and are higher among persons over the age of 40. In this study, approximately 12% of PLWH were hypertensive.	Study did not assess ART duration.

George, McGrath & Oni (2020) (George et al., 2019).	The association between a detectable HIV viral load and non-communicable diseases Comorbidity in HIV positive adults on antiretroviral therapy in Western Cape, South Africa	Analysis of clinic-based records and self-reported data on NCDs in PLWH.	330	There was no significant association between HIV viral load and chronic Comorbidity.	Timing of Comorbidity diagnoses was unknown causality could not be assessed because of the cross-sectional nature of the study.
Hopkins et al (2019) (Hopkins et al., 2019).	Demographics and health profile on precursors of non-communicable diseases in adults testing for HIV in Soweto, South Africa: a cross-sectional study	cross-sectional analysis of health screening programme within the Zazi HTS clinic in Soweto, South Africa.	325	Chronic precursors such as obesity were high among PLWH, females were more likely to have these comorbidities.	The study assessed chronic risk factors and not actual chronic diseases in PLWH. The study was also limited to participants in urban South Africa, Soweto.
Zungu et al (2019) (Zungu et al., 2019b).	Prevalence of non-communicable diseases (NCDs) and associated factors among HIV positive educators: Findings from the 2015/6 survey of Health of Educators in Public Schools in South Africa	Cross sectional analysis of the 2015/6 national educator's survey in South Africa.	2691	Over a third of HIV positive educators presented with another chronic condition, with hypertension being the most common condition reported; being female and aged over 40 was associated with Comorbidity.	The study was limited to educators. Additionally, the cross-sectional nature of the survey did not allow for proper inference of the causality between NCDs and HIV to be made.

2.1.3.5. Challenges with access to healthcare, treatment, and management of HIV CCMs

In South Africa, the ICDM model was introduced in 2011 to address the double burden of HIV and Aids and NCDs (DOH & SANAC, 2013). Some of the key outcomes of the model is to provide: (1) improved operational efficiency and quality of care, (2) individual responsibility, and (3) establish an activated and informed population that can support individuals with living with chronic conditions such HIV and Aids, as well as other NCDs such as hypertension and diabetes (DOH & SANAC, 2013). However, several challenges pertaining to access to healthcare and the management of HIV CCMs exist. Barriers such as long waiting times, staff shortages, and drug stock-outs may have been cited to negatively impact the implementation of similar models to the ICDM model (Ameh et al., 2016). Research shows that at times nurses are not adequately trained to diagnose or manage all diseases, and, given time constraints, are often unable to address all of the patient's concerns (Ameh et al., 2016). With regards to patient's experiences of living with HIV CCMs, a recent study in South Africa by Bosire (2020) found that fragmented care, multiple clinic appointments, conflicting information, poor patient–provider communication, as well as socio-economic factors, costly transport to the hospital, and food insecurity all served as barriers in the management of HIV CCMs (Bosire, 2020).

2.1.4. Gaps in Literature

Research in developed countries and South Africa show that PLWH are at increased risk of developing an additional or second chronic condition (D. J. Kim et al., 2012; H. Lalkhen & Mash, 2015). Chronic conditions, such as stroke and cancer, have been reported among PLWH in high income countries and, partially, in sub-Saharan Africa. Hypertension and cardiovascular risk factors, such as diabetes and dysglycemia, are the most prevalent chronic conditions among adults living with HIV in South Africa (Nlooto, 2017). The socio-economic and demographic factors associated with these CCMs in South Africa have also been documented (Nlooto, 2017; Nyirenda et al., 2013). A wide array of research shows that older age is associated with an increased risk of developing chronic conditions for HIV infected populations. However, in most of the studies reviewed, the time before HIV positive persons are diagnosed with a second chronic condition remains unclear (D. J. Kim et al., 2012; H. Lalkhen & Mash, 2015). Like findings by Chireshe et at. (2019), a prospective study of HIV positive adults on ART in South Africa found that ART compliant adults over the age of 40 years old are at an increased risk of developing hypertension (Brennan et al., 2018). In another study on NCD precursors among PLWH in South Africa adults over the age of 45

years had the highest readings of high blood pressure (Hopkins et al., 2019). Recent literature further shows that PLWH that are diagnosed with cardio metabolic conditions, such as hypertension and diabetes, are less likely to progress along the continuum of care (Chang et al., 2019a).

A methodological limitation in almost all the studies conducted in South Africa on HIV CCMs has been that they have relied on cross-sectional data. Beyond predicting that HIV positive adults will develop an additional chronic condition as they grow older, an identifiable research gap is to assess the time (in terms of age) by which PLWH will develop additional chronic conditions using longitudinal analytical methods. In South Africa, many PLWH remain unaware of their status and are therefore diagnosed at a later stage during their infection (Fomundam et al., 2017). Given that longer HIV duration has also been associated with greater risk of chronic conditions in some studies, PLWH that do not know their seropositive status could be placing themselves at greater risk of HIV CCMs. Among adults that already know their HIV status and on ART, knowledge of the time taken before an HIV positive person develops an additional chronic condition is important. This would ensure that they are timeously initiated on chronic treatment to avoid premature illness and mortality due to HIV CCMs.

Given the challenges already stated with regards to access to treatment and management of chronic conditions in PLWH, an in-depth understanding of the challenges pertaining to prevention, treatment, and care of HIV CCMs affecting both patients and healthcare providers in South Africa is also needed. The importance of addressing these gaps lies in the effort to ensure PLWH can prevent developing additional chronic conditions and that those already infected can receive adequate care and treatment (Nlooto, 2017; Nyirenda et al., 2013).

2.2. Theoretical Framework

This study makes use of three distinct theories to explain the development and care for CCMs among adults in South Africa. Namely, the Social Determinants of Health (SDH) framework, the Vector Model of Complexity (VMC) and the Chronic Care Disease Model (CCDM). The SDH framework postulates that socio-economic, material, and psychosocial factors such as unemployment, level of education, living environment, access to resources, and social support have an impact on individual health behaviours and outcomes (Wilkinson & Marmot, 1998). Inequity in the distribution of these factors can result in a reduced ability to prevent and treat

health problems (Wilkinson & Marmot, 1998). Individuals may experience inequity in more than one of the factors mentioned in SDH model.

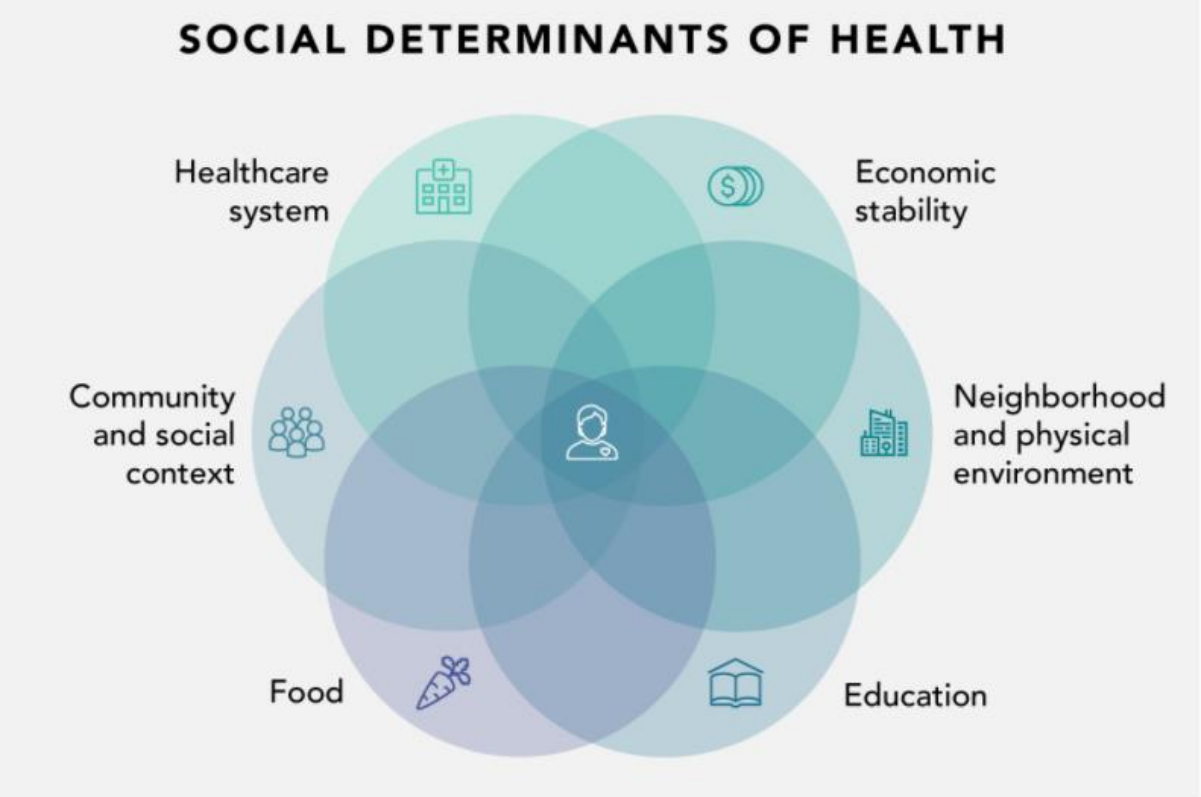

Figure 2.1: Extract of the Social Determinants of Health Model

The VMC explains that the interacting relationship between biological, environmental, behavioural factors, socio-economic, and cultural factors can have a greater impact on health outcomes because individuals are exposed to more than one risk factor (Safford et al., 2007). This can also exacerbate pre-existing conditions or lead to the development of additional medical conditions (Safford et al., 2007). The VMC states that the co-occurrence of multiple medical conditions is complex to care for because in addition to medical treatment, the socio-economic, cultural, psychosocial, and environmental factors may also need to be addressed (Safford et al., 2007).

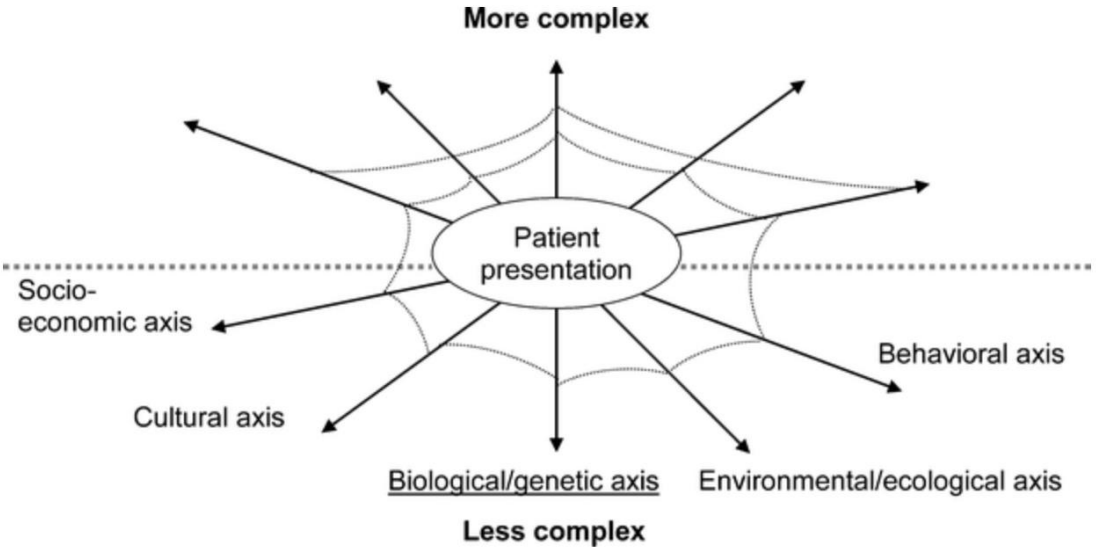

Figure 2.2: Example of Vector Model of Complexity

A disease focused approach to addressing ComorbidityComorbidty comorbidty is therefore not sufficient because, as the SDH and VMC model shows, there are several social factors that also have an impact on health (Safford et al., 2007). Among the holistic approaches adopted in chronic diseases care is the ICDM which proposes a patient centred approach that provides long-term adequate care for patients with chronic diseases. In this model, care for patients with chronic diseases involves supporting patients with the self-management of their conditions, increasing access to healthcare expertise, services and information, reorganizing the roles of healthcare providers to meet the complex needs of patient with chronic diseases, as well as improving systems that monitor patient progress (Wagner, n.d.).

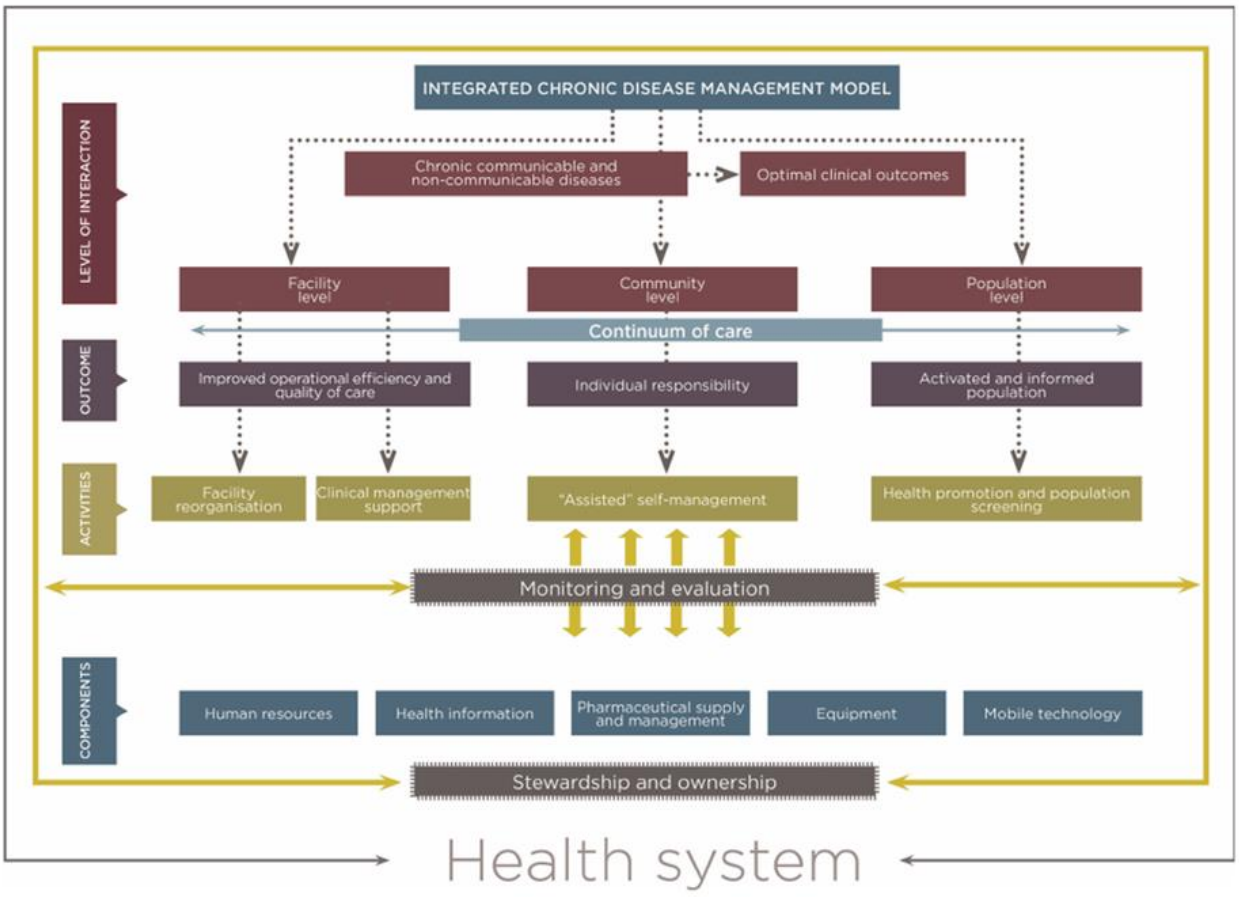

Figure 2.3: Integrated Chronic Disease Model implemented in South Africa, 2011

2.3. Conceptual Framework

The framework presented in the below section is an adaptation of the three theoretical frameworks described above. The below framework is used to explain the development of HIV CCMs in this study and the factors associated with the development of these outcomes. The unit of analysis (individual) which this framework makes prediction is HIV positive adults. HIV infection is not included in the theoretical framework because the study population being assessed in the study is HIV positive (already infected with HIV). The objectives of the study is to draw focus to the risk of chronic conditions among HIV diagnosed and by means of longitudinal analysis retrospectively follow the HIV diagnosed persons to determine development of chronic condition.

The framework shows that, as in the SDH model, biological and socioeconomic factors are among the main determinants of health behaviour and outcomes. Research shows that PLWH share many common risk factors of chronic diseases presented by HIV negative patients.

These include a family history of chronic disease diagnosis, unhealthy diets, physical inactivity, tobacco, and alcohol use (Oni et al., 2015a). In addition, low socio-economic status and gender has been found to be associated with an increased likelihood of chronic risk factors such smoking, poor diet as well as alcohol and drug use (Fleischer et al., 2011). Chronic disease risk factors also differ across males and females, as well as across individuals of different races (Herd et al., 2012).

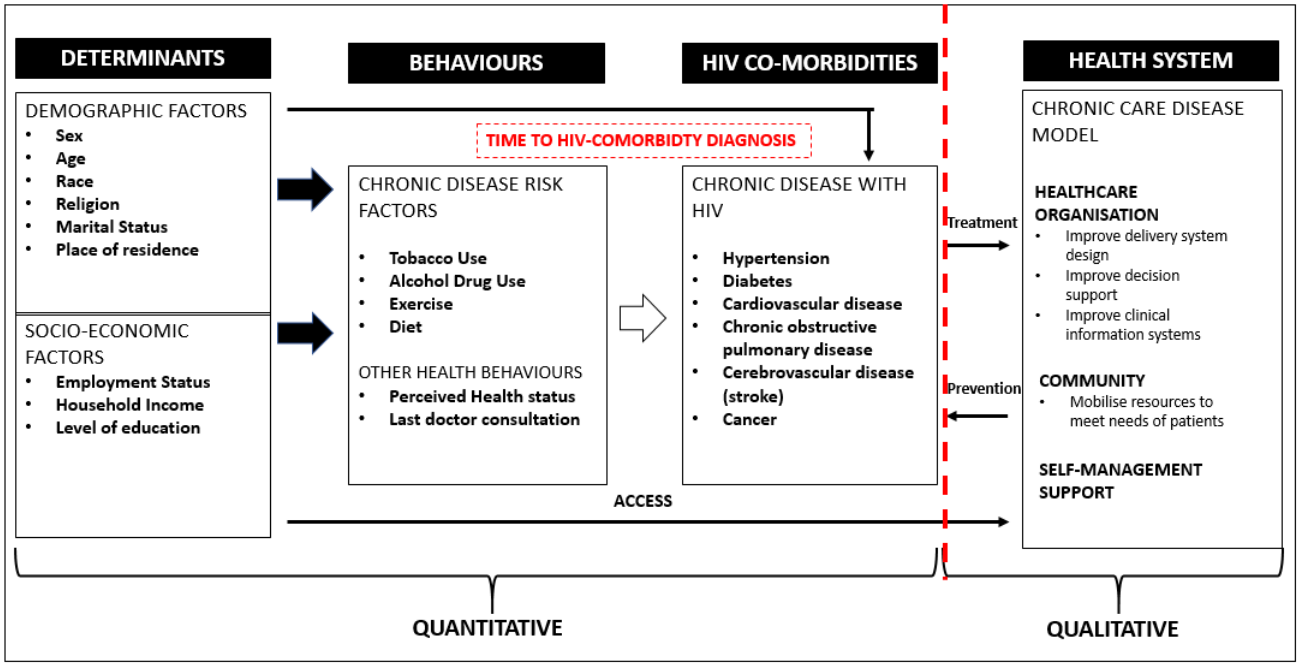

Figure 2.4: Factors associated with the development and care for Chronic Co-morbidities among HIV positive persons.

Source: Adaptation of the WHO Social Determinants of Health Theory, The Vector Model of Complexity and Chronic Care Disease Model (Safford et al., 2007; Wilkinson & Marmot, 1998)

Chronic risk factors lead to the diagnosis of chronic diseases including hypertension, diabetes, CVD, and cancer (Zyl et al., 2012). However, biological characteristics such as age and sex are also significant risk factors for chronic comorbidities (Jalali-Farahani et al., 2017). Among persons already diagnosed with HIV, the diagnosis of additional chronic conditions results in persons living with HIV CCMs. The time before PLWH develop additional chronic conditions is assessed quantitatively. In the conceptual framework above, an HIV positive person with chronic risk factors such as poor diet and exercise as well tobacco, alcohol and drug use are at increased risk of developing HIV CCMs.

Mitigating the risks of HIV CCMs requires addressing both the biological and socio-economic factors, as explained by the VMC. The red dotted line shows the end to the quantitative outcome of this study which is to assess the development of HIV CCMs. At the health systems

level the ICDM model has been adapted in South Africa to improve the quality of care for non-communicable diseases and HIV (Ameh et al., 2016). This study will contribute to the testing of this model (represented after the dotted line), by understanding some of the challenges faced by persons with HIV CCMs - such as access to prevention and treatment.

2.4. Research Hypotheses

The Hypotheses that will be tested in this study are as follows:

Null Hypothesis (Ha_0): An HIV positive adult is not at higher risk of chronic Comorbidity between the ages of 40 - 45 years old.

Alternative Hypothesis (Ha_1): An HIV positive adult is at higher risk of chronic Comorbidity between the ages of 40 - 45 years old.

Null Hypothesis (Hb_0): Demographic; socio-economic and health characteristics are not associated with the time taken before HIV positive adults develop a second chronic condition.

Alternative Hypothesis (Hb_1): Demographic; socio-economic and health characteristics are associated with the time taken before HIV positive adults develop a second chronic condition.

Null Hypothesis (Hc_0): Inability to prevent and access holistic, integrated healthcare decreases the risk for HIV positive adults to develop co-morbidities and affects the management of HIV chronic comorbidities.

Alternative Hypothesis (Hc_1): Inability to prevent and access holistic, integrated healthcare increases the risk for HIV positive adults to develop co-morbidities and affects the management of HIV chronic comorbidities.

The hypotheses measured quantitatively will be tested at a significance level of $p= 0.05$.

CHAPTER THREE: METHODOLOGY

This chapter outlines the planned methods to be undertaken to achieve both the quantitative and qualitative study objectives set out in this study. A detailed description of the study setting, study design, study population and sample, data sources and variables used, analysis methods and ethical considerations are presented. A dissemination plan for the study findings is further included in this section.

3.1. Study Setting

This study is carried out in South Africa. The country comprises of nine provinces, eight metropolitan municipalities including 44 districts and 226 local municipalities. South Africa has a land area of 1, 22 million km^2. In 2018, the country had a population estimated at 57, 725, 600 and one of the largest economies on the African continent (Statistics South Africa, 2018). South Africa is chosen as the preferred study location because of its high prevalence of HIV. For example, the overall prevalence of HIV in South Africa is 20.5% (HSRC, 2018). In addition, the country has an increasing burden of chronic diseases (van Heerden et al., 2017). In 2010 alone, about 39 % of total deaths in the country were due to Non-communicable diseases while about 36% occurred by the age of 60 years old (Statistics South Africa, 2016).

Spatial analysis has shown the EC to be among the provinces with the highest prevalence of chronic ComorbidityComorbidty comorbidty in South Africa (Weimann et al., 2016). In this province, the adult HIV prevalence is 25.2%, which is higher than the national average (20.5%) (HSRC, 2018). In this study, the qualitative sample is obtained from Eastern Cape (EC) and Gauteng. Gauteng is selected because it comprises the largest (14.7 million) share of South African population and has the highest (24.0%) percentage of the elderly population, aged 60 years and older, residing in the province (Statistics South Africa, 2018). About 17.6% of the adult population in Gauteng are living with HIV (HSRC, 2018).

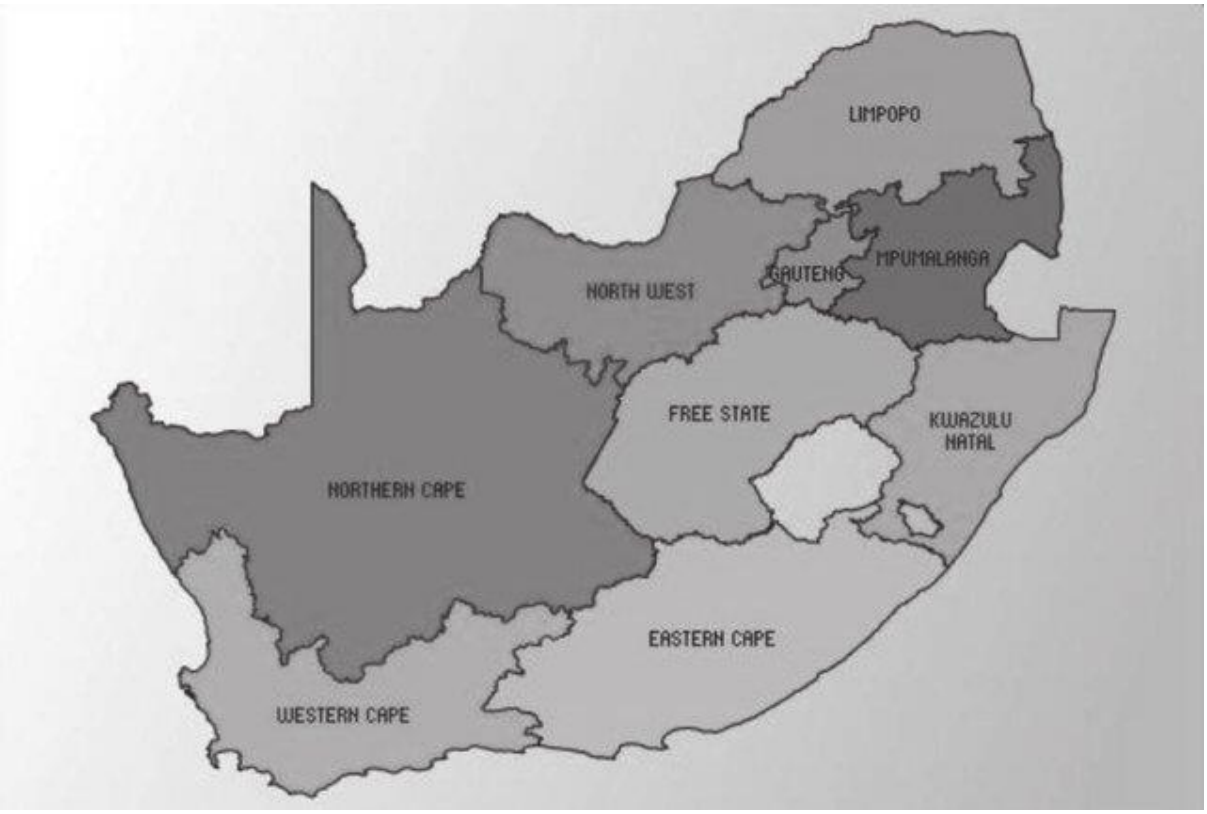

Figure 3.1: Map of South Africa

Source: Statistics SA, 2005

3.2. Study Design

A mixed methods study design is used for this study. The quantitative component in this study involves a retrospective analysis of longitudinal survey data from the National Income Dynamics Survey (NIDS). The NIDS is used because it is a longitudinal dataset that has variables on both HIV status and other chronic conditions such hypertension, cancer, and diabetes for each wave of data collection (Brophy et al., 2018). Secondly, the use of longitudinal data is done because it provides an opportunity to analyse the relationship between risk factors and the development of disease, as well as outcomes of treatments or diseases over time (Caruana et al., 2015). Longitudinal data also allows for the use of event history analysis because it contains 'time-stamped' variables that can determine time to an event and causality. Event history analysis techniques are used in this study to determine the time before PLWH are diagnosed with a second chronic condition. Therefore, longitudinal data is relevant because we can apply event history analysis techniques to answer one of the main objectives of this study which is to determine the time before PLWH are diagnosed with a second chronic condition. Retrospective studies are conducted when study participants have

already experienced the events of interest (Caruana et al., 2015). In this study, the population of interest would have developed HIV CCM within the 2008 and 2017 study period.

Primary data collection was conducted for the qualitative component of this study. It involved conducting Key Informant Interviews (KIIs) with healthcare providers that provide treatment and care to patients living with HIV and other chronic conditions. Thereafter, In-Depth Interviews (IDIs) were conducted with adults living with the Comorbidity of HIV and either hypertension, diabetes, CVD, cancer, or stroke.

3.2.1. Justification for mixed methods approach

The use of mixed-methods is to strengthen the research findings and heighten knowledge and validity (Schoonenboom & Johnson, 2017). In this study, the use of quantitative data from NIDS is because the dataset collects longitudinal data that allows us to explore variables of interest such as HIV, Hypertension, and diabetes, amongst others. Analysing this data retrospectively is done to answer the first and second objective of this study which are (1) To determine the time taken before HIV positive persons develop a second chronic condition and (2) To assess the characteristics associated with the time taken before HIV positive persons develop a second chronic condition). In addition to analysing the NIDS survey, data triangulation is employed by using qualitative methods. This study begins with performing analysis on retrospective data of PLWH with chronic conditions an uses key informant interviews to verify the prevalence and associated factors of chronic conditions among PLWH found in the results of the quantitative analysis. KIIs are further used to answer the third objective of the study by providing an understanding of the experiences and challenges faced by persons living with HIV CCMs and corroborating the quantitative findings Overall, the use of mixed methods in this study is to both quantify and provide an understanding of the dilemma of HIV CCMs in South Africa.

3.3. Study Population

The study population for this research is adults aged 18 -75 years old at wave 1 (2008).This population age group is selected because the legal adult age in South Africa begins from 18 years old while the age group of 75 year is selected because research has shown that older age is associated with an increased risk of chronic risk factors (Tondin et al., 2017; Van Der Vyver, 1997; van Heerden et al., 2017). In addition, the age limit of 75 years is used because according to Thane (1978), old age occurs between the ages of 45 and 55 years for women

and between the ages of 55 and 75 years for men (Thane, 1978). Sampling weights were applied to make the sample representative of the entire population.

The study inclusion criteria are all HIV positive adults. As such, the sample from the NIDS survey was restricted to only HIV positive adults (18-75 years old). The analysis in the study begins at wave 1 because this was the first stage of data collection in the NIDS survey. All adults with HIV and an additional chronic condition at wave 1 have been kept in the analysis to show the prevalence of HIV CCM at the start of the study. Thereafter, all HIV positive adults (18-75 years old) that had not developed a second chronic condition at wave 1 are followed retrospectively until the fifth wave (2017) to determine whether and how long before they develop a second chronic condition within the 2008 and 2017 survey period. All HIV positive adults that did not develop a second chronic condition within the 2008 and 2017 study period have also been kept in the study to account for right censoring.

3.4. The Study Sample

3.4.1. Quantitative Sample

The total weighted adult sample (18 – 75 years old) at wave 1 is 5 961 149. After restricting the sample to HIV positive adults only, a total weighted sample of 95 701 HIV positive adults (18 – 75 years old) at wave 1 remained.

3.4.2. Qualitative Sample

This study makes use of the phenomenological qualitative research method. This method entails understanding the experiences of individuals regarding a particular event or phenomenon (Starks & Trinidad, 2007). The typical sample sizes for phenomenological studies are between 1 and 10 individuals (Starks & Trinidad, 2007). Other authors have recommended that phenomenological studies comprise of at least six participants (Morse, 1994). Given this context, the qualitative sample size for this study is first calculated according to the population and HIV prevalence in the EC. The calculation is as follows:

In wave 1 of the quantitative survey, about 1 106 of the survey population were from the EC. In addition, the adult HIV prevalence was 13.5% at wave 1. Therefore:

Percentage (%) of HIV prevalence at wave 1 **X** population in province at wave 1

- **Eastern Cape:** 13.5% x 1,106 = 149.31

An equal sample to the Eastern Cape was obtained for Gauteng.

- **Gauteng:** 149.31
- **Total sample (EC & Gauteng):** 149 + 149 = 298

However, the purpose of the qualitative component is to corroborate the quantitative findings and understand the challenges faced by HIV persons with CCMs. To achieve the typical sample size of 10 which is normally used for phenomenological studies, IDIs among males and females diagnosed with HIV CCMs were conducted with only 4% of the sample calculated above (i.e. 4% x 298 = 11.92).

Therefore, the total qualitative sample size is 12 IDIs. While a statistical calculation is used for the calculation of the qualitative sample, the data collection process continued until the point of data saturation. IDIs were used because they are useful for providing detailed information about an individual's views, thoughts, and behaviours regarding a particular issue. In this study, using IDIs allowed the persons living with HIV CCMs to provide detailed information about their experiences and thoughts on treatment and access to care for HIV CCMs. Prior to conducting the IDIs, 12 KIIs were conducted with healthcare providers, such as doctors and nurses, that provide care to patients with HIV CCMs. KIIs are used when the intension is to collect information from people who know the population of interest well. The use of KIIs for health care providers is because they are involved in the treatment and care of persons with HIV CCMs. Given the Covid-19 pandemic that surged the world in late 2019 and 2020, some IDIs (7/12) and KIIs (10/12) were conducted telephonically following the restrictions imposed by the South African government which restricted travel to the Eastern Cape and other provinces. Restrictions to face-to-face contact in the form of social distancing further prevented face-to-face research interviews to be conducted. Presented below are the qualitative study sites and the breakdown of the sample size.

Table 3.1: Sample size and data collection sites

Province	Urban/Rural Health Facilities	Participants	Sex/Gender	Method of data collection
EC	***Urban*** Frere Hospital New Haven Chronic Sick Hospital Aspiranza Clinic	X3 persons with HIV CCMs	X2 Males X1Females	IDI
		X3 Health care providers	Any	KII

	Rural SS Gida Hospital Kwelera Clinic	X3 persons with HIV CCMs	X1 Males X2 Females	IDI
		X3 Health care providers	Any	KII
Gauteng	***Urban*** Mary Moodley Clinic Yeoville Clinic	X3 persons with HIV CCMs	X2 Males X1 Females	IDI
		X3 Health care providers	Any	KII
	Peri – Urban Slovoville Clinic Nokuphila Clinic Duduza Clinic	X3 persons with HIV CCMs	X1 Males X2Females	IDI
		X3 Health care providers	Any	KII
Total		**24***		

**Snowballing continued until point of data saturation.*

3.5. Data Sources

3.5.1. Quantitative Data Source

NIDS is a longitudinal survey conducted in all nine provinces in South Africa. The study is conducted every two years. The first Wave of the study began in 2008. Since then, four additional Waves have occurred between 2010 and 2017 (Brophy et al., 2018). The population of interest in all five waves of NIDS were individuals and households. The surveys were administered using three main types of questionnaires namely: The household, adult, children and the proxy questionnaire (Brophy et al., 2018). The adult, household and children data files were merged to obtain all the variables of interest to answer this study's research questions.

In Wave 1 of the survey 400 primary sampling units (PSU) were initially identified. Of these 10 858 households were eligible for selection. However, 10 367 households were selected from the PSU. The number of households that were successfully interviewed was 7 296. Within these households, 31 114 individuals were identified. Of these, 2 918 individuals were excluded as they were not permanent residents of the identified households. This resulted in remainder of 28 226 resident members that became the continuing sampling members (CSM) (Southern Africa Labour and Development Research Unit, 2016). From these CSMs, the total number of successful interviews was 26 776 at wave 1, which remained the same at wave 2. At Wave 3, 28 537 successful interviews were conducted. While at Wave 4, 32 582 individuals were interviewed. Lastly, 37 368 were successfully interviewed at wave 5 (Brophy et al., 2018). The questionnaires were designed to gain insights on various indicators such as the health, education, income, and overall well-being of the South African population over-time. The same questionnaires were administered to the same people at each wave. Further details on the NIDS survey can be obtained from http://www.nids.uct.ac.za/.

3.5.2. Qualitative Sample Design

The qualitative study sample in both the EC and Gauteng was selected using hospital and clinic records. The researcher contacted hospital and clinic staff to recruit the sample of PLWH and additional chronic conditions from the facility's patient records that meet the study criteria and were interested in participating in this study. The snowballing sampling technique was employed to allow the recruited sample to recruit other research participants that meet the study criteria. The snowballing method is useful for hard to reach populations, such as individuals diagnosed with HIV and other illnesses (Bonevski et al., 2014). The data was collected using semi-structured interview guides to obtain a broad understanding of the challenges related to access and treatment of chronic co-morbidities as well as to receive insights on policy issues related to addressing chronic ComorbidityComorbidty comorbidty in South Africa. The interview guides for the IDIs and KIIs are as shown in Appendix C.

3.6. Quantitative Variable Identification

3.6.1. Dependent Variable

Only HIV positive adults were included in the study and followed through to waves 3 and 5. The outcome variable in this study is hypertension diagnosis. The outcome is dichotomous and has two categories (1) Yes and (2) No. The "Yes" represents HIV positive adults who would have developed the outcome and "No" represents those that did not develop hypertension". There are two categories of survey questions in the NIDS adult questionnaire that are of interest in this study. The first category poses questions pertaining to the diagnosis of general chronic conditions while the second category asks respondents to report on any other illnesses that have not covered in the first set of questions. The question on HIV status is posed in the second set of question. HIV status is the inclusion criteria, all participants who mentioned that they are HIV positive in this question were included in the study. The survey questions are presented below:

Table 3.2: NIDS Survey Questions on HIV and Chronic disease diagnosis, 2008 – 2017

Survey Question	Response Categories	Variable	Use in Study
HIV Variable			

Do you have any other major illness or disability not mentioned above?	**1 - Yes** 2 - No -8 - Refused -9 - Don't know	W1 – J17 W2 – J14 W3 – J14 W4 – J14 W5 – J15	This variable was used to identify HIV positive persons. **Yes = Continue**
If yes, what are they? **HIV**	1 - Physically handicapped 2 - Problems with sight, hearing or speech 3 - Psychological or psychiatric disorder **4 - HIV/AIDS** 5 - Epilepsy/ fits 6 - Emphysema 7 - Alzheimer's disease 8 - Other (Specify) -8 - Refused -9 - Don't know	W1 – J18 W2 – J15 W3 – J15 W4 – J15 W5 – J15	This variable was used to identify individuals that are HIV positive for inclusion in the study. The variable was further being used to identify HIV persons that have psychological or psychiatric conditions. The analysis of this variable was used to achieve the 2nd objective. **4 = HIV positive sample (inclusion criteria)**
Other Chronic Conditions			
Have you ever been told by a doctor/nurse that you have **high blood pressure?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.2 W2 – J13.2. a W3 – J13.2. a W4 – J13.2.2 W5 – J13.2.1	This variable was used to identify HIV positive persons that have **high blood pressure** from W1 – W5. The analysis of this variable was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (1)** **1= Diagnosed (2)**
Have you ever been told by a doctor/nurse that you have **Diabetes or high blood sugar?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.3 W2 – J13.3. a W3 – J13.3. a W4 – J13.3.2 W5 – J13.3.2	This variable was used to identify HIV positive persons that have **Diabetes** from W1 – W5. The analysis of this variable was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (2)** **1= Diagnosed (1)**
Have you ever been told by a doctor/nurse that you have **stroke?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.4 W2 – J13.4. a W3 – J13.4. a W4 – J13.4.2 W5 – J13.4.2	This variable was used to identify HIV positive persons that have **Stroke** from W1 – W5. The analysis of this variable was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (2)** **1= Diagnosed (1)**
Have you ever been told by a doctor/nurse that you have **Asthma?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.5 W2 – J13.5. a W3 – J13.5. a W4 – J13.5.2 W5 – J13.5.2	This variable was used to identify HIV positive persons that have **Asthma** from W1 – W5. The analysis of this variable

			was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (2)** **1= Diagnosed (1)**
Have you ever been told by a doctor/nurse that you have **heart problems?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.6 W2 – J13.6. a W3 – J13.6. a W4 – J13.6.2 W5 – J13.6.2	This variable was used to identify HIV positive persons that have **Heart problems** from W1 – W5. The analysis of this variable was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (2)** **1= Diagnosed (1)**
Have you ever been told by a doctor/nurse that you have **cancer?**	1 - Yes 2 - No -8 - Refused -9 - Don't know	W1 – J13.7 W2 – J13.7. a W3 – J13.7. a W4 – J13.7.2 W5 – J13.7.2	This variable was used to identify HIV positive persons that have **Cancer** from W1 – W5. The analysis of this variable was used to achieve the 2nd objective. **<u>Categorised:</u>** **0 = Undiagnosed (2)** **1= Diagnosed (1)**

3.6.2. <u>Independent Variable</u>

The proposed predictor variables, according to the conceptual framework, for CCM among HIV positive adults in this study are presented below:

Table 3.3: Predictor variables in NIDS as according to Conceptual framework

Survey Question	Response Categories	Use in Study
Demographic variables		
What is your date of birth?	dd/mm/year Continuous	This variable was to determine **AGE.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **<u>Categorised:</u>** **0 = ≤35 years** **1= >35 years**
What is your Gender?	1 - Male 2 - Female	This variable was used to determine **SEX.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1.

		Categorised: **1 = Female** **2 = Male**
What is your current marital status?	1 - Married 2 - Living with partner 3 - Widow/Widower 4 - Divorced or separated 5 - Never married	This variable was used to determine **MARITAL STATUS.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:** **1= Never Married (5)** **2 = Married (1 – 4)**
What is your religion?	1 - No religion 2 - Christian 3 - Jewish 4 - Muslim 5 - Hindu 6 - African traditional spiritual beliefs 7 - Other (specify)	This variable was used to determine **RELIGION.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:** **1= Other religion (1; 3–7)** **2= Christian (2)**
What population group would you describe yourself as belonging to?	1 - African 2 - Coloured 3 - Asian/Indian 4 - White 5 - Other (specify) 6 - Refused	This variable was used to determine **RACE.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:** **1= Other races (2 - 8)** **2= African (1)**
Census Sample Geo Type	1 - Traditional 2 - Urban 3 - Farms	This variable was used to determine **PLACE OF RESIDENCE.** The analysis of this variable was to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:** **1= Rural (1/3)** **2= Urban (2)**
Socio-economic variables		
Do you fall in one of the following categories?	0 - Not Economically Active 1 - Unemployed Discouraged 2 - Unemployed Strict 3 - Employed	This variable was to determine **EMPLOYMENT STATUS.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:** **1= Unemployed (0- 2)** **2= Employed (3)**
How would you classify your household in terms of income, compared with other households in	-9 - Don't know -3 - Missing 1 - Much above average income 2 - Above average income 3 - Average income 4 - Below average income 5 - Much below average income	This variable was to determine the **HOUSEHOLD INCOME.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **Categorised:**

your village/suburb?		**1= Below average income (4 -5)** **2= Average income (1-3)**
What is the highest grade in school that you have successfully completed?	0 - Grade R/0 2 - Grade 2/Sub B/Class 2 3 - Grade 3/Std. 1 4 - Grade 4/Std. 2 5 - Grade 5/Std. 3 6 - Grade 6/Std. 4 7 - Grade 7/Std. 5 8 - Grade 8/Std. 6/Form 1 9 - Grade 9/Std. 7/Form 2 10 - Grade 10/Std. 8/Form 3 11 - Grade 11/Std. 9/Form 4 12 - Grade 12/Std. 10/Form 5/Matric/Senior C 14 - NTC 2 16 - Certificate with less than Grade 12/Std 18 - Certificate with Grade 12/Std. 10 19 - Diploma with Grade 12/Std. 10 23 - Higher degree (Masters, Doctorate) 25 - No Schooling	This variable was to determine **LEVEL OF EDUCATION.** The analysis of this variable was used to determine the characteristics of persons with HIV CCMs for objective 1. **<u>Categorised:</u>** **1= No education (25)** **2= Some education (0-3)**
Behaviours		
Do you smoke cigarettes?	1 - Yes 2 - No	This variable was to determine **TOBACCO USE.** The analysis of this variable was used to determine CCM risk among persons with HIV. **<u>Categorised:</u>** **1= No (2)** **2= Yes (1)**
How often do you drink alcohol?	1 - I have never drank alcohol 2 - I no longer drink alcohol 3 - I drink very rarely 4 - Less than once a week 5 - On 1 or 2 days a week 6 - On 3 or 4 days a week 7 - On 5 or 6 days a week 8 - Every day	This variable was to determine **ALCOHOL USE.** The analysis of this variable was used to determine CCM risk among persons with HIV. **<u>Categorised:</u>** **1= Do not drink (1-3)** **2= A few times a month (4-8)**
How regularly do you exercise?	1 - Never 2 - Less than once a week 3 - Once a week 4 - Twice a week 5 - Three or more times a week	This variable was to determine **FREQUENCY OF EXERCISE.** The analysis of this variable was also be used to determine CCM risk among persons with HIV. **<u>Categorised:</u>** **1= Never (1)** **2= At least once a week (2-5)**
How would you describe your health at present? Would you say it is excellent, very good, good, fair or poor?	1 - Excellent 2 - Very Good 3 - Good 4 - Fair 5 - Poor -9 - Don't know	This variable was to determine **PERCEIVED HEALTH STATUS.** The analysis of this variable was also be used to determine CCM risk among persons with HIV. **<u>Categorised:</u>** **1= Poor (4-5)** **2= Good (1-3)**
When did you last consult someone about your health?	1 - In the last 30 days 2 - One to five months ago 3 - Six to twelve months ago 4 - More than one and less than two years ago	This variable was to determine **LAST DOCTOR'S CONSULTATION** The analysis of this variable was also be

	8 - Never	used to determine CCM risk among persons with HIV. **<u>Categorised:</u>** **1= In the last 30 days (1)** **2= More than a month ago (2-8)**

3.7. Data Analysis

This section outlines the statistical analysis that was conducted on the data from the NIDS to answer objectives one and two set out in this study. The qualitative analysis conducted in line with objective four of the study is also described.

3.7.1. <u>Quantitative Analysis</u>

Objective 1: To show estimates of the prevalence of HIV CCMs among HIIV positive adults (18 - 75 years old) in South Africa.

All of the quantitative data was analysed in STATA version 14.0 To obtain all the variables of interest, the adult data file was merged with the child and household data files. After merging the datasets, the study achieved the first objective by providing descriptive statistics of the levels of each chronic condition (HIV, Hypertension, diabetes, stroke, CVD, and cancer) at wave 1 of the NIDS survey to determine the most prevalent HIV CCMs in the study population. The logic for the calculation is depicted below:

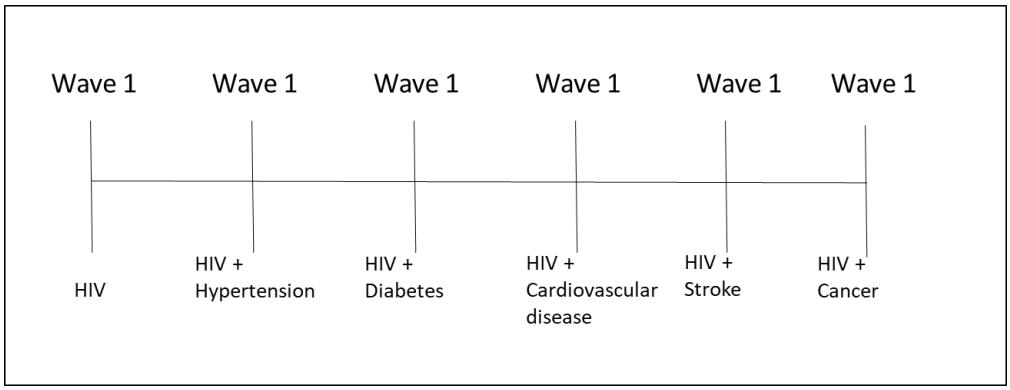

Figure 3.2: Logic for calculation of prevalence of HIV and CCM

Objective 2: To estimate the time to which and types of chronic co-morbidities developed among HIV-positive adults (18 – 75 years old) in South Africa.

Survival and Event History Analysis techniques were used to answer the first objective of this study. These methods of analysis are used to determine the duration until an event of interest occurs, as well as the point in time in which the event occurs (Cook & Lawless, 2015). The event of interest in this study is the occurrence of HIV CCMs. Survival analysis allowed us to determine whether an HIV positive adult enrolled in the study developed an HIV CCM within the study observation period, as well as the duration before this event of interest occurred. However, the data under analysis was left censored because the date/time in which the adults first developed HIV was unknown. The issue of right censoring, whereby an HIV positive adult would not have developed a second chronic condition by the end of the 2017 study period or dropped out of the study, was also accounted for by reformatting the data in a person-period data file to allow for longitudinal data analysis. Left truncation which arises when an individual has already experienced the event of interest before entering the study was also accounted for by keeping all persons with HIV CCMs at wave 1 in the study (Steele, 2005).

Several techniques exist within survival and event history analysis. These include parametric and non-parametric models. The former makes assumptions about the distribution of the data (when the event of interest will occur) while the latter is based on no assumptions. Research has shown that the time in which HIV CCMs occur is unclear (Sonnenberg et al., 2005). However, this study hypothesises that an HIV positive adult is at risk of developing a chronic Comorbidity between the ages of 40 and 45 years old. Given that some form of assumption is made about the data, this study first made use of the cox proportional hazard model which is a semi-parametric model and used to measure the probability that the event of interest will occur. In this study the cox proportional hazard model was used to assess whether persons diagnosed with HIV would have developed a second chronic condition (HIV CCM) by the age of 45 (Cox, 1972). Risk time was the age of HIV CCM diagnosis. The model equation for the cox proportional hazard method is as follows:

$$\frac{h\left(t,\mathbf{X}^{*}\right)}{h\left(t,\mathbf{X}\right)}=\exp\left[\sum_{i=1}^{p}\hat{\beta}_{i}\left(X_{i}^{*}-X_{i}\right)\right]$$

Where:
$h_0(t,)$ = baseline hazard
$\boldsymbol{X\ (X_1,X_2 \ldots X_p)}$ = explanatory/predictor variables
β_i = probability of censored subjects

Source: (DR Cox 1972)

The logic of analysis for the time to HIV CCM diagnosis is depicted in figure 3 below:

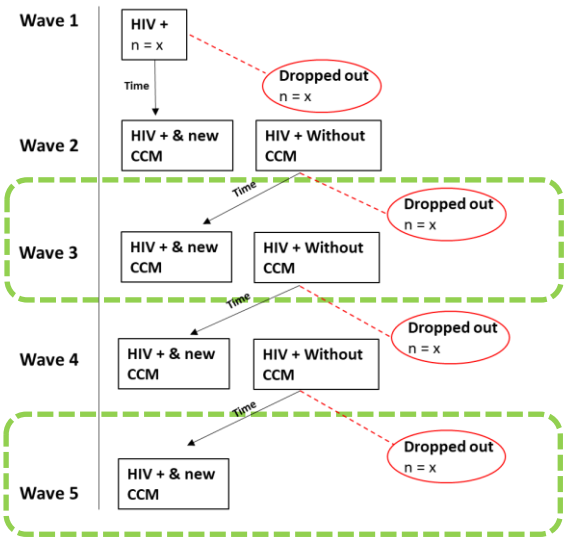

Figure 3.3: Logic for measuring time to HIV CCM diagnosis

The figure above depicts that the analysis began with HIV positive persons at wave 1, who were retrospectively followed to wave 3 to determine whether they develop a CCM. After accounting for the rate of attrition (HIV + persons that dropped out of the study), the remaining adults with HIV that did not develop a CCM were again retrospectively followed until the last wave (wave 5) to examine whether, and how long, it took for them to develop a CCM. The outcome of interest (HIV CCM diagnosis) was assessed at wave 3 and 5 of the NIDS survey.

The Kaplan Meier survival analysis is another non-parametric model that was utilised to estimate and plot the duration of exposure before the risk of HIV CCMs occur, as well as account for censored time (time participant drops out of study). The model equation for Kaplan Meier method is as follows:

$$S(t_i) = \prod_{t_i \leq t} \left(1 - \frac{d_i}{n_i}\right)$$

Where:
S (ti) = estimated survival probability at time *t*
ni = number of people at risk of the event of interest at the beginning of time period t_i
di =number of diseases that occurred at time t_i

Source: (Kaplan & Meier 1958)

The plot provides a graphical depiction of the time (represented by the age in years) to the occurrence of CCM among persons with HIV, for the duration of their stay in the study (wave 1-5).

Objective 3: To describe the demographic, socio-economic, and health-related characteristics associated with the time taken before HIV positive adults (18 – 75 years old) develop a second chronic condition in South Africa.

Descriptive statistics of the demographic; socio-economic and health characteristics of the adults with HIV and the additional chronic condition at each of the study waves (1- 4) are first presented. Thereafter, cox regression was used to assess the effect of each of the predictor variable on the development of CCM diagnosis at wave 3 and 5. The level of significance was set at $p<0.05$. The adjusted and unadjusted results are presented and interpreted as hazard ratios.

3.7.2. Qualitative Analysis

Objective 4: To understand the challenges regarding prevention, access to treatment, and management of HIV chronic co-morbidities faced by adults (18 - 75 years old) with HIV chronic co-morbidities in South Africa.

KIIs and IDIs were conducted with healthcare workers in PHC and adults with HIV CCMs, respectively. The interviews were premised around the following broad themes:

Health Systems Challenges

1. Challenges with providing and receiving treatment and care under the Integrated Chronic Disease Model
2. Available programmes for HIV CCMs

Treatment and care challenges

3. Challenges with the prevention of HIV CCMs
4. Management of Comorbidities
5. Access to treatment and care

Other themes explored

6. Social Interactions; including care for children and the elderly after HIV CCM diagnosis.
7. Disclosure of additional chronic diseases (in workplace, to spouse, family etc.) after initial disclosure of HIV status

The profile for the participants sampled in the IDIs was that the person was HIV positive, on ART, and living with an additional chronic condition. These interviews were useful in assisting to understand the challenge regarding prevention and access to chronic care as well as gain insight on the difficulties with managing HIV CCMs and the support programmes that are in place to assist adults living with these comorbidities. All interviews were administered using semi-structured interview guides. The interviews were audio recorded and, where conducted in a local language, transcribed to English. Thematic content analysis was done using Atlas ti version 8.0 qualitative analysis package. The content was analysed inductively to generate new knowledge on challenges with living with HIV CCMs. The fieldwork was conducted as outlined in Appendix F.

3.8. Ethical Considerations

Ethical clearance (M190683) was obtained from the Human Research Ethics Committee (HREC - Medical) based at the University of the Witwatersrand, Johannesburg. After being provided with a study information sheet, all eligible study participants provided either written or verbal consent. All verbal consents were audio recorded. Administrative permission was further obtained from the Provincial and District Departments of Health in Gauteng and the Eastern Cape.

3.9. Dissemination Plan

The findings in this study will be disseminated through journal publications, as well as at regional and international conferences. A minimum of three journal publications are the planned doctoral outputs from this study, the remainder of which will be published at a post-doctoral level. At present, one manuscript has been accepted for publication, one is currently under review, and one is in draft. The table below describes the manuscript submission and the schedule of planned conference presentations.

Table 3.4: Planned Dissemination of Study Findings

Title of submission	Name of Journal/Conference	Status
Journals		
The Comorbidity of HIV, Hypertension and Diabetes: A qualitative study exploring the challenges faced by healthcare providers and patients in selected urban and rural health facilities where the ICDM model is implemented in South Africa	BMC Health Services Research	Published https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-021-06670-3
Time to hypertension Comorbidity among HIV positive adults in South Africa: A longitudinal analysis of the National Income Dynamics Survey (NIDS)	Heliyon	Published https://www.sciencedirect.com/science/article/pii/S2405844021018533
Hypertension among young adults living with HIV: A systematic review of causes and challenges	BMC Public Health	Submitted
Conferences		
The Comorbidity of HIV, Hypertension and Diabetes: A qualitative study exploring the challenges faced by healthcare providers and patients in selected urban and rural health facilities where the ICDM model is implemented in South Africa	Population Association of America (PAA); USA	Presented – 05 May 2021
Time to hypertension Comorbidity among HIV positive adults in South Africa: A longitudinal analysis of the National Income Dynamics Survey (NIDS)	South African AIDS Conference	Abstract submitted. Conference rescheduled to the February 2021

CHAPTER FOUR: RESULTS

This chapter provides the results from the analysis undertaken to assess levels of HIV CCMs, the time taken before adults develop HIV CCMs, the demographic, socio-economic, and health characteristics associated with the development of HIV CCMs among adults aged 18-75 years old as well as the challenges faced by this population of adults in South Africa.

The study was first undertaken quantitatively and profiles all HIV positive adults surveyed in the NIDS from 2008. The chapter begins by providing the levels of HIV in the study. The levels of HIV CCMs at wave 1 (2008) are also presented to identify which HIV CCMs are the most prevalent in the study. Thereafter, using Kaplan Meier survival estimates, the time (age in years) taken before the adults in this study developed HIV chronic comorbidities is graphically represented. The analysis for the time taken to HIV CCM was conducted at midline (Wave 3: 2012) and end line (Wave 5: 2017) of the NIDS survey. This is because while the NIDS survey is conducted every second year, adults may take a long time before showing signs or symptoms of chronic conditions. Assessing the time to HIV CCM diagnosis at midline and end line is done to allow the HIV sample a longer period to show signs of additional chronic conditions. For example, there is at least four years between wave 1 (2008) and wave 3 (2012), and at least five years between wave 3 (2012) and wave 5 (2017).

The results from the adjusted cox regression analysis are then presented to show the demographic, socio-economic, and health characteristics that are associated with the development of HIV chronic comorbidities at wave 3 and wave 5 of the study. In the regression model, the demographic, socio-economic, and health characteristics at wave 1 and 2 are used to explain the development of HIV CCMs at wave 3, while the characteristics at waves 3 and 4 are used to explain the development of HIV CCMs at wave 5. This manuscript reports of the findings that are in line with the study objectives. Other quantitative findings of interest such as the unadjusted hazard ratios and the time to HIV CCM diagnosis at waves two and four have been provided in Appendix A of this report.

Finally, the findings from the HCWs and the HIV CCM diagnosed patients were assessed under six broad themes namely: (1) treatment and care challenges; (2) health system challenges; (3) availability of HIV CCMs programmes at the primary care level; (4) Challenges with the prevention of HIV CCMs; (5) management of HIV CCMs; and (6) access to treatment and care. The findings are reported using sub-thematic headings and illustrative quotes. Other qualitative findings of interest which fell outside of the study's objectives have been included under Appendix B of this report.

4.1. Wave 1: Prevalence of HIV and Chronic Comorbidities

The first objective of this study was to show the prevalence of HIV CCMs among HIV positive adults (18 - 75 years old) in South Africa. A total weighted sample of 5 961 149 participants was obtained from the merged NIDS dataset. The NIDS sample was restricted to HIV positive adults between the ages of 18 – 75 years old. After applying this restriction, the weighted sample of HIV positive adults at wave 1 was 95 701. In accordance with the first objective, the prevalence of HIV CCMs was assessed at wave 1 to show the chronic conditions that most affected PLWH in the study's population. N= 95 701

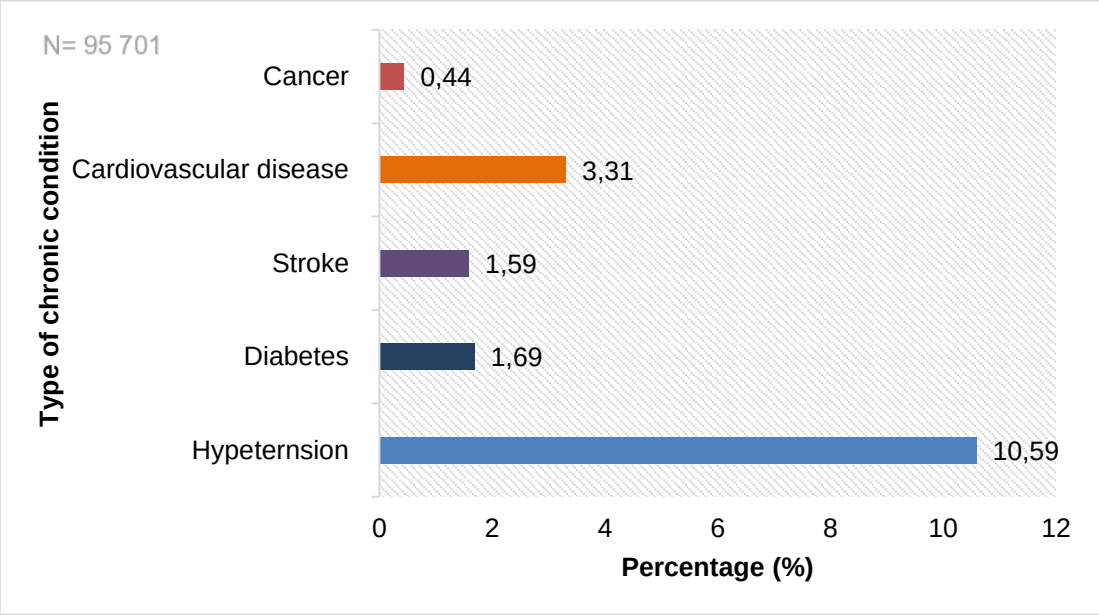

Figure 4.1: Levels of HIV CCMs at wave 1, NIDS 2008

Figure 4.1 shows that of the 95 701 HIV positive adults at wave 1, at least n=10 131 (10.5%) had hypertension Comorbidity. This is followed by heart problems n= 3171 (3.3%), diabetes n=1 615 (1.6%), stroke n= 1525 (1.5%) and cancer n= 423 (0.4%). Aside from hypertension, the levels of these chronic conditions are low (<5%). Therefore, CVD, diabetes, cancer, and stroke variables were dropped from the study analysis because their prevalence among the HIV positive sample was low. Supporting the exclusion of these variables from the analysis is research that has found that while chronic conditions, such as stroke and cancer, have been reported among PLWH in High Income Countries and partially in sub-Saharan Africa, hypertension represents the cardiovascular risk group that is most prevalent among adults living with HIV in South Africa (Nlooto.,2017). The focus on hypertension is also because adults with HIV and hypertension Comorbidity are at greater risk of other cardiovascular conditions (Okeke et al., 2016).

4.2. Wave 1: Characteristics of HIV positive adults living with hypertension Comorbidity

Presented below are the percentage and frequency distribution showing the demographic, socio-economic and health characteristics associated with HIV and hypertension Comorbidity.

Table 4.1: Weighted frequencies and percentages of demographic characteristics of HIV positive adults diagnosed with hypertension at wave 1

	Hypertension Comorbidity		
Demographic Variables	**Diagnosed N= 10 131**	**Undiagnosed N=85 569**	**Total N=95 701**
Age			
≤ 35 years **(%)**	4 244.5 **(41.9)**	28 053.1 **(32.8)**	32 269.3 **(33.7)**
>35 years **(%)**	5 887.2 **(58.1)**	57 516.5 (**67.2)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	9 843.4 **(97.2)**	61 064.9 **(71.4)**	70 908.5 **(74.0)**
Male **(%)**	288.3 **(2.9)**	24 504.7 **(28.6)**	24 793.1 **(25.9)**
Marital status			
Never married **(%)**	6 807.2 **(67.2)**	52 543.5 **(61.4)**	59 350.7 **(62.0)**
Married **(%)**	3 324.4/ **(32.8)**	33 026.2 **(38.6)**	36 350.7 **(37.9)**
Religion			
Other religion **(%)**	0 **(0.0)**	5 610.4 **(6.6)**	5 610.4 **(5.8)**
Christian **(%)**	10 131.7 **(100.0)**	79 959.2 **(93.4)**	90 091.0 **(94.1)**
Race			
Other (%)	1 186.4 **(11.7)**	423.4 **(0.5)**	1 609.9/95 701 **(1.6)**
African (%)	8 945.3 **(88.3)**	85 146.2 **(99.5)**	94 063.2/95 701 **(98.3)**
Place of residence			
Rural **(%)**	2 364.0 **(23.3)**	54 119.6 **(63.3)**	56 563.6 **(59.0)**
Urban **(%)**	7 767.7 **(76.7)**	31 370.1 **(36.7)**	39 137.9 **(40.9)**
Socio-economic Variables			
Employment status			
Unemployed **(%)**	8 945.3 **(88.3)**	78 488.3 **(91.7)**	87 433.7 **(91.3)**
Employed **(%)**	1 186.4 **(11.7)**	7 081.4 **(8.3)**	8 267.8 **(8.6)**
Household income			
B/low average **(%)**	6 573.2 **(64.8)**	66 968.4 **(83.1)**	73 541.7 **(81.0)**
Average **(%)**	3 558.5 **(35.1)**	13 637.8 **(16.9)**	17 196.3 **(18.9)**
Education level			
No education **(%)**	2 805.3 **(27.7)**	18 562.6 **(21.7)**	21 368.0 **(22.3)**
Some education **(%)**	7 326.4 **(72.33)**	67 007.0 **(78.3)**	74 333.5 **(77.6)**
Health behaviour Variables			
Tobacco use			
No **(%)**	8 236.5 **(81.3)**	67 586.4 **(79.0)**	75 822.9 **(79.2)**
Yes **(%)**	1 895.2 **(18.7)**	17 983.3 **(21.0)**	19 878.5 **(20.7)**

Alcohol use			
Do not drink **(%)**	7 090.5 **(70.0)**	66 119.2 **(77.3)**	73 209.8 **(76.5)**
Few times a month**(%)**	3,041.2 **(30.0)**	19 450.5 **(22.7)**	22 491.7 **(23.4)**
Exercise			
Never **(%)**	6 457.7 **(63.7)**	77 151.3 **(90.2)**	83 609.0 **(87.3)**
1nce a week **(%)**	3 674.0 **(36.3)**	8 418.4 **(9.8)**	12 092.4 **(12.6)**
Perceived Health			
Poor **(%)**	7 019.6 **(69.3)**	69 085.4 **(80.7)**	76 105.0 **(79.5)**
Good **(%)**	3 112.1 **(30.7)**	16 484.3 **(19.3)**	19 596.4 **(20.4)**
Last Dr consultation			
Last 30 days **(%)**	9 843.4 **(97.2)**	55 625.6 **(65.0)**	65 469.1 **(68.4)**
1month + ago **(%)**	288.3**(2.9)**	29 944.1 **(35.0)**	30 232.4 **(31.5)**

According to Table 4.1, of the 10 131 adults diagnosed with HIV and hypertension at wave 1, the majority (58.1%) were above 35 years, female (97.1%), never married (67.1%), all were Christian (100%), most were black Africans (88.2%) and residing in urban areas of South Africa (76.6%).

From the 10 131 HIV positive adults diagnosed with hypertension Comorbidity at wave 1, a large proportion (88.2%) were unemployed, had a below average household income (64.8%) and about 72.3% had received some education

In terms of health behaviours, about 81.2% and 69.9% of HIV positive with hypertension reported to not smoke or drink alcohol, respectively. A large proportion said they never exercise (63.7%), almost 70% reported to have poor health and about 97% had consulted with a doctor in the last 30 days.

4.3. Wave 3: Levels of HIV and Hypertension Comorbidity

Table 4.2: Prevalence of HIV and hypertension Comorbidity at wave 3

Comorbidity Type	Weighted Frequency (N)	Percentage (%)
Hypertension		
Diagnosed	6,900.1	7.2
Undiagnosed	88,801.4	92.8
Total	95,701.56	100

As per Table 4.4 above, between wave 1 and wave 3, the number of undiagnosed adults increased from 85 569 to 88 801. As such the prevalence of HIV positive adults diagnosed with hypertension Comorbidity declined from 10.5% % to 7.2%. Reasons adduced for the decrease in the sample of adults with HIV and hypertension Comorbidity could be that the participants who first reported to be hypertensive at wave 1 were placed on antihypertensive

treatment and managed to have their high blood pressure under control. As a result, it is possible that they did not report diagnosis at the proceeding waves. Alternatively, the prevalence of hypertension could have declined because of attrition. For example, the adults with hypertension died or refused to participate at wave 3 of the survey.

4.4. Wave 3: Characteristics of HIV positive sample

Table 4.3: Weighted frequencies and percentages of demographic characteristics of HIV and hypertension Comorbidity at wave 3

	Hypertension Comorbidity		
Demographic Variables	**Diagnosed N= 6 900**	**Undiagnosed N= 88 801**	**Total N= 95 701**
Age			
≤ 35 years **(%)**	1 213.0 **(17.5)**	31 084.6 **(35.0)**	32 297.1 **(33.7)**
>35 years **(%)**	5 687.0 **(82.4)**	57 716.7 **(64.9)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	2 078.0 **(30.1)**	27 130.2 **(30.5)**	29 208.2 **(74.0)**
Male **(%)**	4 822.1 **(69.8)**	61 671.2 **(69.4)**	66 493.3 **(25.9)**
Marital status			
Never married **(%)**	2 354.7 **(34.1)**	70 948.0 **(79.8)**	73 302.8 **(62.0)**
Married **(%)**	4 545.3 **(65.8)**	17 853.3 **(20.1)**	22 398.6 **(37.9)**
Religion			
Other religion **(%)**	1 489.8 **(21.5)**	48 154.1 **(54.2)**	49 643.9 **(51.8)**
Christian **(%)**	5 410.3 **(78.4)**	40 647.3 **(45.7)**	46 057.6 **(48.1)**
Race			
Other (%)	0 **(0.0)**	7 952.5 **(8.9)**	7 952.5 **(8.3)**
African (%)	6 900.1 **(100.0)**	80 848.8 **(91.0)**	87 749.0 **(91.6)**
Place of residence			
Rural **(%)**	6 035.1 **(87.4)**	36 000.3 **(40.5)**	42 035.5 **(43.9)**
Urban **(%)**	864.9 **(12.5)**	52 801.0 **(59.4)**	53 666.0 **(56.0)**
Socio-economic Variables			
Employment status			
Unemployed **(%)**	6 900.1 **(100.0)**	64 306.1 **(72.4)**	71 206.2 **(74.4)**
Employed **(%)**	0 **(0.0)**	24 495.3 **(27.6)**	24 495.3 **(25.6)**
Household income			
B/low average **(%)**	5 884.6 **(85.3)**	60 997.3 **(68.7)**	66 881.9 **(69.8)**
Average **(%)**	1 015.4 **(14.7)**	27 804.0 **(31.3)**	28 819.5 **(30.1)**
Education level			
No education **(%)**	4 592.4 **(66.6)**	23 695.9 **(26.7)**	28 288.3 **(29.5)**
Some education **(%)**	2 307.7 **(33.4)**	65 105.4 **(73.3)**	6 413.2 **(70.4)**
Health behaviour Variables			
Tobacco use			

No **(%)**	3,370.2 **(48.8)**	84,648.8 **(95.3)**	88,019.1 **(91.9)**
Yes **(%)**	3,529.8 **(51.2)**	4,152.5 **(4.7)**	7,682.4 **(8.0)**
Alcohol use			
Do not drink **(%)**	6,702.5 **(82.1)**	72,935.3 (**97.1)**	79,637.9 **(83.2)**
Few times a month **(%)**	197.5 **(17.9)**	15,866.0 **(2.9)**	16,063.6 **(16.7)**
Exercise			
Never **(%)**	5,884.6 **(85.3)**	71,985.5 **(81.1)**	77,870.2 **(81.3)**
1nce a week **(%)**	1,015.4 **(14.72)**	16,815.8 **(18.9)**	17,831.3 **(18.6)**
Perceived Health			
Poor **(%)**	0 **(0.0)**	37,438.4 **(42.2)**	37,438.4 **(39.1)**
Good **(%)**	6,900.1 **(100.0)**	51,363.0 **(57.8)**	58,263.1 **(60.8)**
Last Dr consultation			
Last 30 days **(%)**	1,292.2 **(18.7)**	49,034.3 **(55.2)**	50,326.5 **(52.5)**
1month + ago **(%)**	5,607.9 **(81.3)**	39,767.0 **(44.8)**	45,374.9 **(47.4)**

Table 4.3 shows that of the 6 900 adults with HIV and hypertension Comorbidity at wave 3, a large proportion were aged above 35 years old (82.4%), were largely male (69.8%), married (65.8%), Christian (78.4%), predominately Black Africans (100%) and the majority were residing in rural areas of South Africa (87.4%).

Comorbidity In terms of socio-economic status, the largest proportion of adults living with HIV and hypertension Comorbidity at wave 3 were unemployed (100%), with a low household income (85.2%), and above average had no education (66.5%)

Comorbidity In wave 1 about 81.2% and 69.9% of HIV positive with hypertension reported to not smoke or drink alcohol, respectively. At wave 3, over half of the HIV positive adults diagnosed with hypertension Comorbidity smoked tobacco (51.1%). However, a large proportion (82.1%) said they did not drink alcohol but also never exercised (85.2%). All reported to have good health (100%) and most said that their last doctor's visit was more than a month ago (81.2%)

4.5. Wave 3: Time taken to hypertension Comorbidity

The second objective of this study was to estimate the time before HIV positive adults (18 - 75 years old) develop a second chronic condition in South Africa. After establishing that hypertension is the most prevalent (10.5%) chronic condition among adults living with HIV, only the HIV positive sample that were not hypertensive at wave 1 (n= 85 569/95 701) were retrospectively followed to wave 3 to assess the time taken before they developed hypertension. Kaplan survival estimates were used to estimate the time. The time is

represented by the age at which the adults (aged 18 – 75 years old) developed the hypertension Comorbidity.

Important to note is that because the inclusion criteria for the study is HIV positive adults (18-75 years old), the risk of hypertension Comorbidity provided in the results of the survival estimates is applicable for adults who are diagnosed with HIV by or on their 18th year or with. The time taken to hypertension diagnosis is then measured as the difference between the age of entering the survey as HIV positive and the age at which a chronic condition was developed. Given that the HIV infection variable is unknown, the study makes an assumption that adults diagnosed with HIV anytime after their 18th birthday will have approximately the same length of time before developing hypertension and those with higher exposure of chronic risk factors will have a shorter time for the development of HIV CCMs

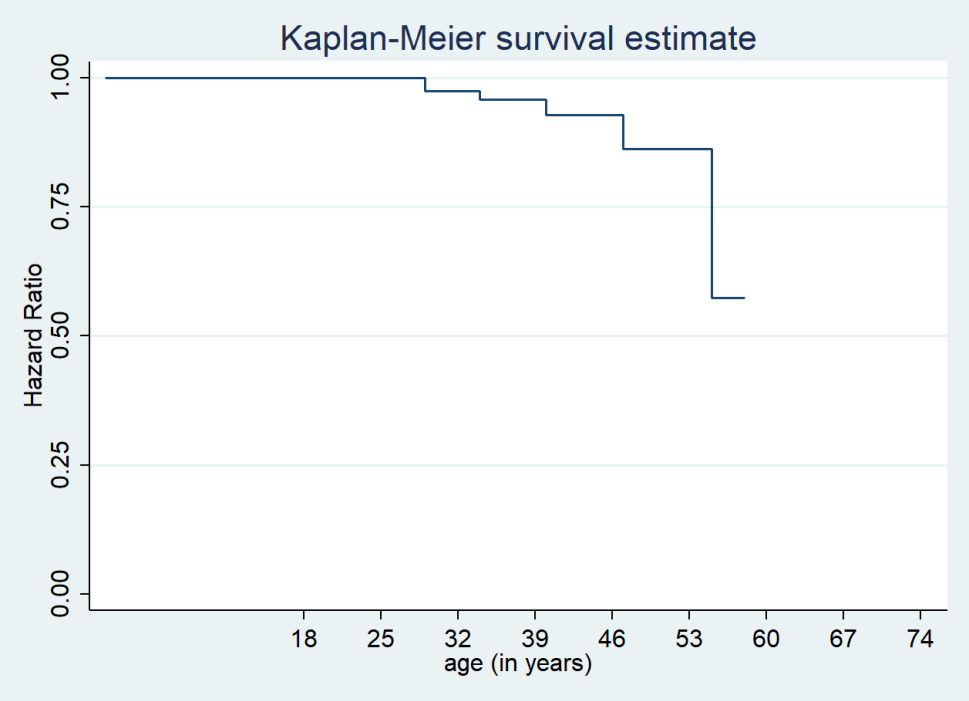

Figure 4.2: Hazard of hypertension Comorbidity at wave 3

Figure 4.2 shows that at wave 3 of the NID survey, the risk of developing hypertension was highest among adults aged over 30 years old. The vertical x-axis represents the hazard ratio or risk and the horizontal x-axis indicate the age in which the HIV positive adults in this study became at risk of hypertension. As shown in figure 4.2, before the age of 30, the risk of developing hypertension is low, as represented by the horizontal hazard line showing that the event of interest (hypertension) did not occur. From the age of 30, the hazard line begins to change, showing that the event of interest has occurred. Over 80% of HIV positive adults aged 30 - 46 years old were at risk of developing hypertension Comorbidity. At the age of 53, the

survival curve drops sharply indicating that the risk of developing hypertension increases sharply but begins to decrease after this age (represented by the horizontally flattening curve). Thereafter the risk of hypertension Comorbidity began to decrease with an increase in age after age 46. In other words, the risk of hypertension began to reduce once the adults living with HIV turned 46 years old. The hazard of developing hypertension Comorbidity decreases significantly to about 55% from the age of 53.

4.6. Wave 3: Cox Regression for factors associated with Hypertension Comorbidity at wave 3

The Cox Proportional Hazard regression was used to assess the effect of each demographic, socio-economic, and health characteristics on the development of hypertension Comorbidity at wave 3 to achieve the third objective of this study. The demographic, socio-economic, and health characteristics at wave 1 (2008) and 2 are assessed to check whether they explain the development hypertension Comorbidity among HIV positive adults at wave 3, respectively. Adjusted outcomes of each predictor variable is presented to control for the confounding influence of other variables. The findings are presented as hazard ratios (HR) with 95% confidence intervals (CI).

Table 4.8: Adjusted Likelihood ratios of demographic; socio-economic and health factors at wave 1 that are associated with hypertension Comorbidity at wave 3

Characteristics	Adjusted Ratio (p-value)	[95% Confidence Intervals]
Demographic		
Marital status		
Never married	RC	
Married	0.60 (0.639)	0.077 - 4.816
Religion		
Other religion	RC	
Christian	1.29 (0.844)	0.100 - 16.659
Place of residence		
Rural	RC	
Urban	2.35 (0.505)	0.189 - 29.424
Socio-economic		
Employment status		
Unemployed	RC	
Employed	1.37 (0.796)	0.125 - 15.106
Household income		
B/low average	RC	
Average	0.26 (0.343)	0.016 - 4.169
Health Characteristics		

Frequency of alcohol use		
Do not consume	RC	
At least once a week	0.56 (0.757)	0.015 - 20.918
Frequency of exercise		
Never	RC	
At least once a week	0.31 (0.381)	0.025 - 4.116
Perceived health status		
Poor	RC	
Good	5.00 (0.252)	0.318 - 78.690
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	1.09 (0.940)	0.097 - 12.381

RC= reference category

**Some variables have been dropped from the adjusted model because they were not fit for the Cox Model (i.e. Gender; Race; Level of education; Tobacco Use)*

In Table 4.8 above of the adjusted model, the risk of hypertension Comorbidity is reduced by 40% for married adults living with HIV as opposed to adults that have never been married (HR: 0.60; CI:0.077 – 4.816). Compared to adults from other religious denominations, the hazard of hypertension Comorbidity is higher among Christian adults living with HIV (HR: 1.29; CI: 0.100 – 16.659). Adults living with HIV and residing in urban areas have an increased risk of developing hypertension Comorbidity as compared to those residing in rural areas (HR: 2.35; CI: 0.189 – 29.424).

The hazard of hypertension Comorbidity is higher among HIV positive adults that are employed as compared to adults there were unemployed (HR: 1.37; CI: 0.124 – 15.106). The risk of hypertension Comorbidity was reduced by 74% among adults living with HIV and earning an average household income when compared to adults that had a below average household income (HR: 0.26; CI: 0.016 – 4.169).

In terms of health characteristics, the hazard of hypertension Comorbidity is reduced among HIV positive adults that consume alcohol at least once a week as compared to those that do not drink (HR: 0.56; CI 0.015 – 20.918). Similarly, there is a decreased risk of developing hypertension Comorbidity among adults that exercise at least once a week compared to those that never exercise (HR: 0.31; CI:0.025 – 4.116). The hazard of developing hypertension Comorbidity is higher among HIV positive adults that rated their health as good compared to adults that rated their health as poor (HR: 5.00; CI: 0.318 – 78.690). Lastly, adults living with HIV who had consulted with a doctor more than a month ago have an increased risk to develop hypertension Comorbidity compared to adults that reported to have visited a doctor in the last

30 days (HR: 1.09; CI:0.097 – 12.381). However, none of these findings were significant (p> 0.05).

Table 4.9: Adjusted Likelihood ratios of demographic; socio-economic and health factors at wave 2 that are associated with hypertension Comorbidity at wave 3

Characteristics	Adjusted Hazard ratios (p-value)	[95% Confidence Intervals]
Demographic		
Gender		
Female	RC	
Male	0.22 (0.364)	0.009 - 5.601
Marital status		
Never married	RC	
Married	1.85 (0.710)	0.072 - 47.643
Religion		
Other religion	RC	
Christian	0.03 (0.123)	0.001 - 2.466
Place of residence		
Rural	RC	
Urban	0.04 (0.136)	0.001 - 2.641
Socio-economic		
Employment status		
Unemployed	RC	
Employed	0.12 (0.262)	0.003 - 4.747
Household income		
B/low average	RC	
Average	194.39 (0.081)	0.526 - 71797.240
Education Level		
No education	RC	
Some education	10.62 (0.350)	0.074 - 1514.991
Health Characteristics		
Tobacco Use		
No	RC	
Yes	1.25 (0.908)	0.027 - 58.973
Frequency of alcohol use		
Do not consume	RC	
At least 1nce a week	3.89 (0.412)	0.151 - 100.27
Perceived health status		
Poor	RC	
Good	-1.91 (0.057)	1.183 – 5.800
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	10.28 (0.350)	0.078 - 1361.4

RC= reference category
**Significant (p= <0.05)*
***Some variables have been dropped from the adjusted model because they were not fit for the Cox Model as indicated in the unadjusted regression = Race, Frequency of Exercise*

In the adjusted model, there risk of hypertension Comorbidity is decreased by 78% among male adults living with HIV as compared to females (HR: 0.22; CI: 0.009 – 5.601). There is an increased risk of hypertension Comorbidity among married adults living with HIV as opposed to adults that have never been married (HR: 1.85; CI:0.072 – 47.643). Compared to adults from other religious denominations, the hazard of hypertension Comorbidity is reduced by 97% for Christian adults living with HIV (HR: 0.03; CI: 0.005 – 2.466) as compared to other religious denominations. Adults living with HIV and residing in urban areas have a lower risk of developing hypertension Comorbidity compared to those residing in rural areas (HR: 0.04; CI: 0.001 – 2.641).

The hazard of hypertension Comorbidity is also lower among HIV positive adults that are employed as compared to adults there were unemployed (HR: 0.12; CI: 0.003 – 4.748). Adults living with HIV and earning an average household income had an increased risk to develop hypertension Comorbidity compared to adults that had a below average household income (HR: 194.39; CI: 0.526 - 71797.24). In terms of level of education, the hazard of hypertension Comorbidity is higher among HIV positive adults that have received some education compared to those that have no education (HR: 10.62; CI: 0.075 - 1514.991).

With regards to health characteristics, the hazard of hypertension Comorbidity is higher among HIV positive adults that smoke tobacco compared to those that do not smoke (HR: 1.25; CI: 0.027 - 58.973). The hazard of hypertension Comorbidity is higher among HIV positive adults that consume alcohol at least once a week as compared to those that do not drink (HR: 3.89; CI: 0.151 - 100.274). In the adjusted model, a borderline significant association is found between religion and hypertension development among PLWH. The hazard of developing hypertension Comorbidity is higher for HIV positive adults that rated their health as good compared to adults that rated their health as poor (HR: -1.91; CI: 5.80006 - 1.18296). Lastly, adults living with HIV who had consulted with a doctor more than a month ago have an increased risk to develop hypertension Comorbidity compared to adults that reported to have visited a doctor in the last 30 days (HR: 10.28; 0.078 - 1361.4). Aside from perceived health, none of these findings were significant ($p< 0.05$).

The reason for the lack of significant association between the variables and the development of hypertension in Tables 4.8 and 4.9 respectively, is possibly an implication of the data management. Given the limited cases in each of the categories the categorization of the independent variables was made into binary variables (i.e. with only two categories). This was done to increase the number of cases for each variable in order for regression model to be performed (Table 4.9) .

4.7. Wave 5: Levels of HIV CCMs

Table 4.10: Levels of HIV CCMs at wave 5

Comorbidity Type	Weighted Frequency (N)	Percentage (%)
Hypertension		
Diagnosed	10 637.8	11.1
Undiagnosed	85 063.7	88.9
Total	**95 701.56**	**100**

According to Table 4.10, between 2012 (wave 3) and 2017 (wave 5), the number of HIV positive adults diagnosed with hypertension Comorbidity increased to 10 637. Evidently, there is a 3.91 percentage increase in new diagnosis of hypertension among adults living with HIV in this study.

4.8. Wave 5: Characteristics of HIV positive sample

Percentage and frequency distribution of the demographic, socio-economic, and health characteristics of the adults diagnosed with HIV and hypertension at wave 5 of the NIDS are presented. This is done to account for any changes in the characteristics between the third and fifth wave.

Table 4.11: Weighted frequencies and percentages of demographic characteristics of HIV and hypertension Comorbidity at wave 5

	Hypertension Comorbidity		
Demographic Variables	**Diagnosed N= 10 637**	**Undiagnosed N= 85 063**	**Total N= 95 701**
Age			
≤ 35 years **(%)**	5,648.7 **(53.1)**	26,648.9 **(31.3)**	32,297.7 **(33.7)**
>35 years **(%)**	4,989.0 **(46.9)**	58,414.8 **(68.7)**	63,403.8 **(66.2)**
Gender			
Female **(%)**	7,541.8 **(70.9)**	39,014.7 **(45.9)**	46,556.5 **(48.7)**
Male **(%)**	3,096.0 **(29.1)**	46,048.9 **(54.1)**	49,145.0 **(51.3)**
Marital status			
Never married **(%)**	4,957.8 **(46.6)**	74,839.0 **(88.0)**	79,796.9 **(83.4)**
Married **(%)**	5,679.9 **(53.4)**	10,224.6 **(12.0)**	15,904.6 **(16.6)**
Religion			
Other religion **(%)**	0 **(0.0)**	39,975.4 **(47.0)**	39,975.4 **(41.8)**
Christian **(%)**	10,637.8 **(100.0)**	45,088.3 **(53.0)**	55,726.1 **(58.2)**
Race			
Other (%)	1,651.6 **(15.5)**	26,693.0 **(31.4)**	28,344.7 **(29.6)**
African (%)	8,986.2 **(84.5)**	58,370.6 **(68.6)**	67,356.8 **(70.4)**
Place of residence			
Rural **(%)**	2,048.5 **(19.3)**	36,922.3 **(43.4)**	38,970.9 **(40.7)**
Urban **(%)**	8,589.2 **(80.7)**	48,141.3 **(56.6)**	56,730.6 **(59.3)**

Of the 10 637 adults with HIV and hypertension Comorbidity at wave 5, over half were aged below 35 years old (53.1%), the majority were female (70.9%), the majority were married (53.3%), all were Christian (100%), predominately black Africans (84.4%) and the majority were residing in urban areas of South Africa (80.7%) (Table 4.11) .

Table 4.12: Weighted frequencies and percentages of the Socio-economic characteristics of HIV positive adults by hypertension Comorbidity at wave 5

	Hypertension Comorbidity		
Socio-economic Variables	**Diagnosed N= 10 637**	**Undiagnosed N= 85 063**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	9,581.9 **(90.1)**	75,535.4 **(88.8)**	85,117.3 **(88.9)**
Employed **(%)**	1,055.9 **(9.9)**	9,528.3 **(11.2)**	10,584.2 **(11.1)**
Household income			
B/low average **(%)**	5,085.1 **(47.8)**	51,085.0 **(60.1)**	56,170.2 **(58.7)**
Average (**%)**	5,552.6 **(52.2)**	33,978.6 **(39.9)**	39,531.3 **(41.3)**
Education level			
No education **(%)**	2,048.5 **(19.3)**	22,753.8 **(26.8)**	24,802.4 **(25.9)**
Some education **(%)**	8,589.2 **(80.7)**	62,309.8 **(73.3)**	70,899.1/ **(74.1)**

In terms of socio-economic status, the largest proportion of adults living with HIV and hypertension Comorbidity are unemployed (90%), just over half have an average household income (52.2%) and the majority have received some form of education (80.7%) (Table 4.12)

Table 4.13: Weighted frequencies and percentages of the of Health behaviour characteristics of HIV positive adults by hypertension Comorbidity at wave 5

	Hypertension Comorbidity		
Health behaviour Variables	**Diagnosed N= 10 637**	**Undiagnosed N= 85 063**	**Total N= 95 701**
Tobacco use			
No **(%)**	7,856.7 **(73.9)**	75,804.7 **(89.1)**	83,661.4 **(87.4)**
Yes **(%)**	2,781.0 **(26.1)**	9,259.0 **(10.9)**	12,040.0 **(12.6)**
Alcohol use			
Do not drink **(%)**	-	-	-
Few times a month **(%)**			
Exercise			
Never **(%)**	9,184.9 **(86.3)**	64,454.0 **(75.8)**	73,639.0 **(76.9)**
1nce a week **(%)**	1,452.8 **(13.7)**	20,609.6 **(24.2)**	22,062.5 **(23.1)**
Perceived Health			
Poor **(%)**	0 **(0.0)**	32,644.2 **(38.4)**	32,644.2 **(34.1)**
Good **(%)**	10,637.8 **(100.0)**	52,419.4 **(61.6)**	63,057.2 **(65.9)**
Last Dr consultation			
Last 30 days **(%)**	7,856.77 **(73.9)**	46,892.2 **(55.1)**	54,749.0 **(57.2)**
1month + ago **(%)**	2,781.0 **(26.1)**	38,171.4 **(44.9)**	40,952.5 **(42.8)**

* Wave 5 of the NIDS survey did not collected data for the variable = Alcohol Use

With regards to health behaviours, only about 26.1% of HIV positive adults diagnosed with hypertension Comorbidity smoked tobacco. A large proportion (86.3%) never exercise, all reported to have good health (100%) and most said that their last doctor's visit occurred in the last 30 days (73.8%) (Table 4.13).

4.9. Wave 5: Time taken to hypertension Comorbidity

The study has established that an additional 3.9% of HIV positive adults developed hypertension by the end of wave 5, 2017. In a further analysis to achieve the second objective of this study which was to estimate the time before HIV positive adults (18 – 75 years) develop hypertension, (n= 88,801/95 70) HIV positive adults in the study that did not develop hypertension Comorbidity at wave 3 were again retrospectively followed to wave 5 to assess the time taken before they developed hypertension Comorbidity. Kaplan survival estimates were used to estimate the time. The time is again represented by the age at which the adults (aged 18 – 75 years old) developed the hypertension Comorbidity.

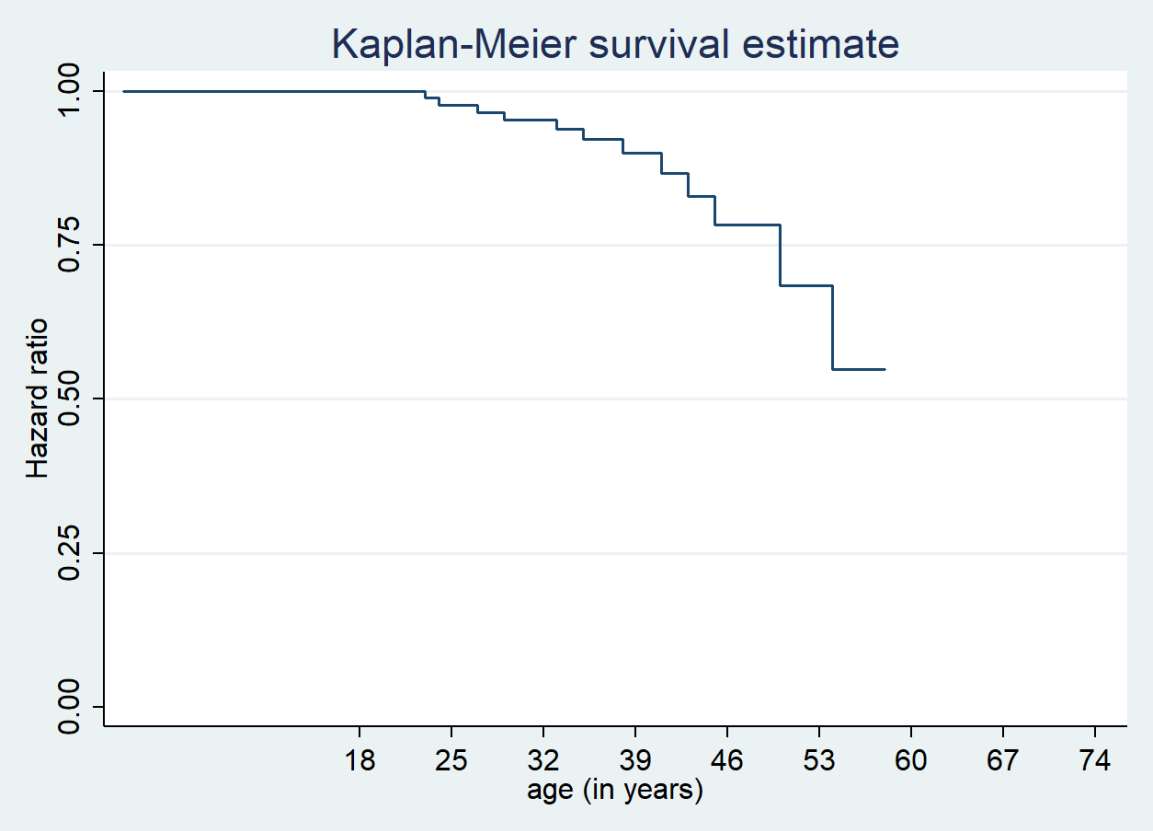

Figure 4.3: Hazard of hypertension Comorbidity at wave 5

At wave 5 of the NID survey (figure 4.3) the hazard of HIV positive adults developing hypertension Comorbidity began from the age of about 23 years. Adults diagnosed with HIV were not at risk of hypertension before the age of 23, as represented by the horizontal hazard line. After the age of 23 the hazard line begins to change, showing that the event of interest (hypertension) has occurred. The highest risk of hypertension Comorbidity was between the ages of 23 – 45. Over 75% of HIV positive adults within this age group were at risk of developing hypertension. Thereafter, the risk of hypertension Comorbidity begins to decrease with an increase in age after age 45. In other words, the risk of hypertension began to reduce once the adults living with HIV turned 45 years old. The hazard drops to about 70% at the age of about 48 and further down to approximately 52% by the age of 53. The hazard of developing hypertension Comorbidity remained low from the age of 53.

4.10. Wave 5: Cox Regression for factors associated with Hypertension Comorbidity

Finally, to achieve the objective of describing the demographic, socio-economic, and health-related characteristics associated with HIV positive adults (18 - 75 years old) developing hypertension. The Cox Proportional Hazard regression was again used to assess the effect of each demographic, socio-economic, and health characteristics on the development of hypertension Comorbidity at wave 5. The demographic, socio-economic, and health characteristics at wave 3 and 4 are used to determine whether they explain the development of hypertension Comorbidity among HIV positive adults at wave 5, respectively. Again, only adjusted results are presented to control for the effect of covariates in the relationship between each predictor and HIV and hypertension Comorbidity. The findings are presented as hazard ratios (HR) with 95% confidence intervals (CI).

Table 4.14: Adjusted Likelihood ratios of demographic; socio-economic and health factors at wave 3 that are associated with hypertension Comorbidity at wave 5

Characteristics	Adjusted Hazard ratios (p-value)	[95% Confidence Intervals]
Demographic		
Gender		
Female	RC	
Male	0.37 (0.351)	0.048 - 2.950
Marital status		
Never married	RC	
Married	1.54 (0.606)	0.297 - 8.0150
Religion		

Other religion	RC	
Christian	2.41 (0.490)	0.198 - 29.421
Place of residence		
Rural	RC	
Urban	0.41 (0.169)	0.120 - 1.449
Socio-economic		
Employment status		
Unemployed	RC	
Employed	1.37 (0.676)	0.311 - 6.073
Household income		
B/low average	RC	
Average	1.37 (0.702)	0.269 - 7.030
Education Level		
No education	RC	
Some education	2.16 (0.372)	0.398 - 11.733
Health Characteristics		
Tobacco Use		
No	RC	
Yes	0.93 (0.955)	0.092 - 9.488
Frequency of alcohol use		
Do not consume	RC	
At least once a week	1.84 (0.592)	0.197 - 17.244
Frequency of exercise		
Never	RC	
At least once a week	1.65 (0.524)	0.352 - 7.773
Perceived health status		
Poor	RC	
Good	0.37 (0.487)	0.024 - 5.862
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	0.69 (0.749)	0.076 - 6.396

RC= reference category

**Some variables have been dropped from the adjusted model because they were not fit for the Cox Model as indicated in the unadjusted regression = Race*

In Table 4.14 of the adjusted model, there is a decreased risk of hypertension Comorbidity among males compared to females (HR: 0.37; CI: 0.048 - 2.950). Married adults living with HIV have an increased risk of hypertension Comorbidity compared to adults that have never been married (HR: 1.54; CI: 0.297 - 8.015). Compared to adults from other religious denominations, the hazard of hypertension Comorbidity is higher among Christian adults living with HIV (HR: 2.41; CI: 0.198 - 29.421). The risk of hypertension Comorbidity is reduced by 59% for adults living with HIV and residing in urban areas compared to those residing in rural areas (HR: 0.41; CI: 0.120 - 1.450).

The hazard of hypertension Comorbidity is higher among HIV positive adults that are employed compared to adults there were unemployed (HR: 1.37; CI: 0.311 - 6.073). Adults living with HIV and earning an average household income had an increased risk to develop hypertension Comorbidity compared to adults that had a below average household income (HR: 1.37; CI: 0.269 - 7.030). In terms of level of education, the hazard of hypertension Comorbidity is higher among adults with some education compared to those with no education (HR: 2.16; CI: 0.398 - 11.733).

In terms of health characteristics, the hazard of hypertension Comorbidity is lower among HIV positive adults that smoke tobacco compared to adults that do not smoke (HR: 0.93; 0.092 - 9.488). The risk of hypertension Comorbidity is higher among HIV positive adults that consume alcohol at least once a week as compared to those that do not drink (HR: 1.84; CI: 0.197 - 17.244). There is an increased risk of developing hypertension Comorbidity among adults that exercise at least once a week compared to those that never exercise (HR: 1.65; CI: 0.352 - 7.773). The hazard of developing hypertension Comorbidity is lower among HIV positive adults that rated their health as good compared to adults that rated their health as poor (HR: 0.37; CI: 0.024 - 5.862). Lastly, the risk of hypertension Comorbidity is decreased by 31% for adults living with HIV who had consulted with a doctor more than a month ago compared to adults that reported to have visited a doctor in the last 30 days (HR: 0.69; CI: 0.076 - 6.396). However, none of these findings were significant ($p < 0.05$).

Table 4.15: Adjusted Likelihood ratios of demographic; socio-economic and health factors at wave 4 that are associated with hypertension Comorbidity at wave 5

Characteristics	Adjusted Hazard ratios (p-value)	[95% Confidence Intervals]
Demographic		
Gender		
Male	RC	
Female	0.59 (0.590)	0.0919 - 3.887
Marital status		
Never married	RC	
Married	2.76 (0.374)	0.294 - 25.922
	Religion	
Other religion	RC	
Christian	2.46 (0.366)	0.347 - 17.555
	Race	
Other religion	RC	
African	0.31 (0.302)	0.0346 - 2.839
	Place of residence	
Rural	RC	
Urban	0.37 (0.239)	0.0716 - 1.933
	Socio-economic	
	Employment status	

Unemployed	RC	
Employed	0.32 (0.438)	0.0191 - 5.558
Household income		
B/low average	RC	
Average	0.69 (0.683)	0.118 - 4.065
Education Level		
No education	RC	
Some education	0.62 (0.526)	0.142 - 2.708
Health Characteristics		
Tobacco Use		
No	RC	
Yes	5.28 (0.140)	0.579 - 48.238
Frequency of alcohol use		
Do not consume	RC	
At least 1nce a week	2.82 (0.283)	0.425 - 18.755
Frequency of exercise		
Never	RC	
At least once a week	2.75 (0.358)	0.318 - 23.852
Perceived health status		
Poor	RC	
Good	0.09 (0.063)**	0.007 - 1.138
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	0.45 (0.429)	0.064 - 3.209

RC= reference category
***marginal significance*

In the adjusted model shown in Table 4.15, there is a lower risk of hypertension Comorbidity among females compared to males (HR: 0.59; CI: 0.092 - 3.887). Married adults living with HIV have an increased risk of hypertension Comorbidity as opposed to adults that have never been married (HR: 2.76; CI: 0.294 - 25.922). Compared to adults from other religious denominations, the hazard of hypertension Comorbidity is higher among Christian adults living with HIV (HR: 2.46; CI: 0.347 - 17.555). The risk of hypertension Comorbidity is lower by 63% among adults residing in urban areas compared to those residing in rural areas (HR: 0.37; CI: 0.072 - 1.933).

The hazard of hypertension Comorbidity is lower among HIV positive adults that are employed compared to adults there were unemployed (HR: 0.32; CI: 0.019 - 5.557). Adults living with HIV and earning an average household income had an lower risk to develop hypertension Comorbidity compared to adults that had a below average household income (HR: 0.69; CI: 0.118 - 4.065). In terms of level of education, the risk of hypertension Comorbidity is reduced by 38% among adults with some education as compared to those with no education (HR: 0.62; CI: 0.142 - 2.708).

In terms of health characteristics, the hazard of hypertension Comorbidity is higher among HIV positive adults that smoke tobacco compared to adults that do not smoke (HR: 5.28; 0.579 - 48.238). The risk of hypertension Comorbidity is higher among HIV positive adults that consume alcohol at least once a week compared to those that do not drink (HR: 2.82; CI: 0.425 - 18.754). There is an increased risk of developing hypertension Comorbidity among adults that exercise at least once a week compared to those that never exercise (HR: 2.75; CI: 0.318 - 23.852). The hazard of developing hypertension Comorbidity is lower among HIV positive adults that rated their health as good compared to adults that rated their health as poor (HR: 0.09; CI: 0.007 - 1.138). Lastly, adults living with HIV who had consulted with a doctor more than a month ago have a decreased risk to develop hypertension Comorbidity compared to adults that reported to have visited a doctor in the last 30 days (HR: 0.45; CI: 0.064 - 3.209). However, none of these findings were significant ($p < 0.05$).

4.11. Description of Qualitative Study Population

The fourth and final objective of this study was to understand the challenges regarding prevention, treatment, and access to healthcare faced by adults (18 - 75 years old) with HIV CCMs in South Africa. For this purpose, a mix of healthcare providers was sampled for inclusion in the study. Figure 4.5 below shows the types of healthcare providers that were successfully interviewed across three hospitals and nine clinics. One doctor was based in a rural hospital. Among the HCWs eleven were females and one was male.

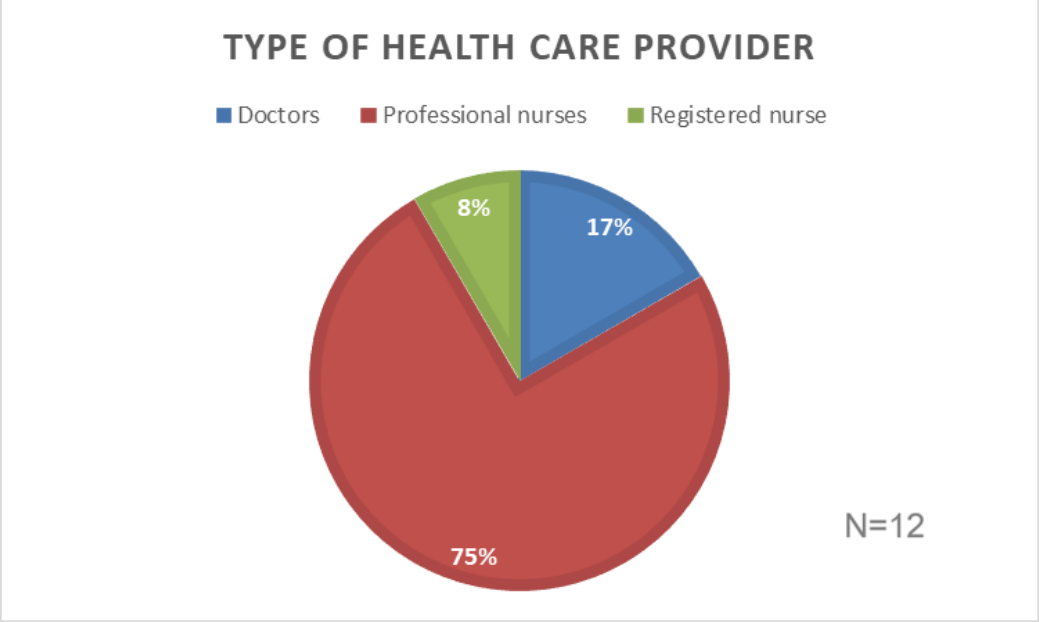

Figure 4.5: Type of HCWs Interviewed

Proceeding the interviews with HCW, twelve IDIs were conducted with adults living with the Comorbidity of HIV and hypertension, diabetes, and epilepsy across the Eastern Cape (6) and Gauteng (6). The sample of adults was recruited from clinic records provided by healthcare providers. About 83% of the HIV positive qualitative sample had hypertension. Other chronic diseases reported by adults living with HIV in the sample included diabetes (9%) and epilepsy (8%) as shown in figure 4.6 below (figure 4.6) .

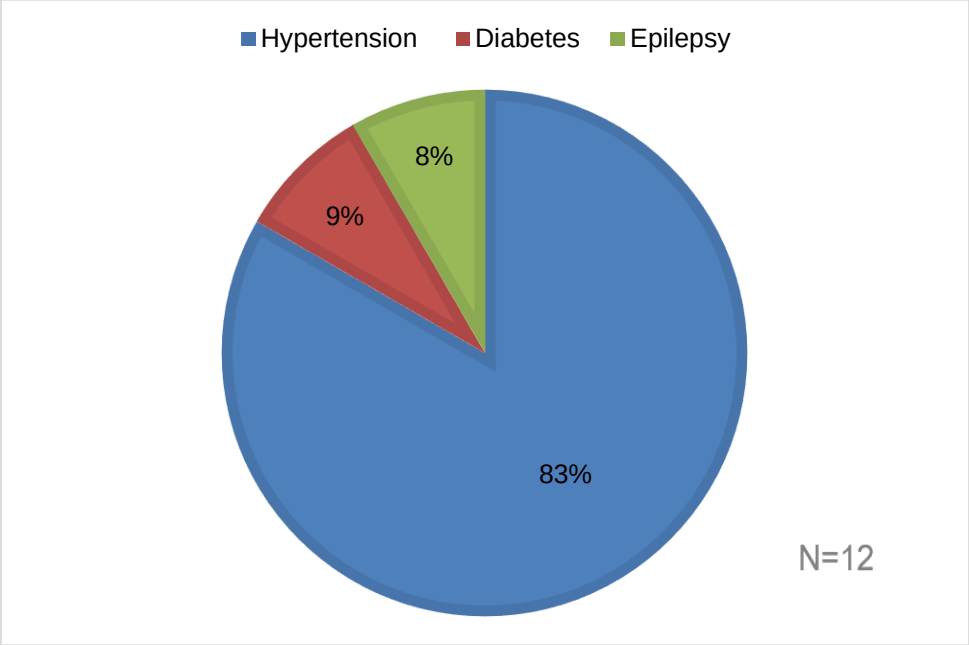

Figure 4.6: Prevalent chronic conditions among qualitative sample of adults living with HIV

As shown in table 4.16 below, the adults living with HIV CCMs sampled in the qualitative component of this study were mostly aged 46 – 50 years old (33.3%), over 90% were female and single (58.3%), and a large majority had received secondary education (66.6%). In terms of employment status, there was an equal number of adults that were employed and unemployed included in the study (50%).

Table 4.16: Characteristics of sample of adults living with HIV CCMs

AGE	Frequency (N)	Percentage (%)
30 – 35	2	16.7
36 – 40	2	16.7
41 – 45	1	8.3
46 – 50	4	33.3
51 – 55	2	16.7
56 – 60	1	8.3
SEX		
Female	11	91.7
Male	1	8.3
MARITAL STATUS		
Single	7	58.3

Married	3	25.0
Divorced/Separated	2	16.7
LEVEL OF EDUCATION		
Primary	3	25.0
Secondary	8	66.6
Matric	1	8.3
EMPLOYMENT STATUS		
Employed	6	50.0
Unemployed	6	50.0

The adults were asked to recall both the year of their HIV diagnosis as well as the year/month they became diagnosed with hypertension. This information was used to derive the number of years they have been living with an HIV CCM. From table 4.17 below, while 13 years was the longest number of years the adult participants have been living with HIV CCMs, overall the participants had been living with HIV CCMs for an average of 4 years.

Table 4.17: Duration of HIV CCM Diagnosis among patient participants

Participant	Type of HIV CCM	Duration (years) of HIV CCM diagnosis
P1 - GP	HIV/HBP	13
P2 - GP	HIV/HBP	1
P3 - GP	HIV/HBP	13
P4 - GP	HIV/HBP	1
P5 - GP	HIV/HBP	1
P6 - EC	HIV/HBP	6
P7 - EC	HIV/DM	3
P8 - EC	HIV/HBP	1
P9 - EC	HIV/HBP	2
P10 - EC	HIV/Epilepsy	3
P11 - EC	HIV/HBP	1
P12- GP	HIV/HBP	1

4.12. Challenges faced by Healthcare providers and Patients Diagnosed with HIV CCMs

The findings from the provider and patient interviews are organised into main headings and sub-themes.

4.12.1. Prevention

4.12.1.1. Lack of information

There is minimal satisfaction from adults attending primary healthcare facilities on the information provided for the prevention of HIV CCMs. The majority of study participants report having received no or inadequate information on the prevention of HIV CCMs. Where chronic information was provided, it was not thorough and often emphasised in silos. For example, HIV prevention education is given separately from other chronic disease prevention. As a result, most participants were unaware of how to prevent developing HIV Chronic multi-morbidities or prevent worsening their current chronic comorbidities. Some of the experiences of the patient participants are as follows:

> *"By the time I was diagnosed in 2015, I didn't know anything about hypertension…I only assumed it was for elderly people…I never thought that a younger person can also have it…I didn't know anything and mine was high to an extent that I even had stroke."*
>
> ***P1, GP.***

> *"I am lacking information on such matters…the information I have is for HIV, is when I have a boyfriend, I must use a condom…I know that I shouldn't stress over everything in life…that's all I know, it is not enough you see!"*
>
> ***P10, EC.***

> *"I did not get much information about HIV and ways of preventing vulnerability from other chronic diseases, the information I got was very vague…they only said when you diagnosed with HIV it's easy to get other diseases but that time, I didn't have diabetes or know it existed."*
>
> ***P7, EC.***

> *"I didn't know it's (hypertension) preventable or could be prevented…at the HIV section they told us that don't have sex with a man without using a condom...Not to drink alcohol but drink our pills and not to think too much…they only asked me that why do I have stress and why do I think too much and so on, but they didn't provide me information on how to avoid stress."*
>
> ***P3, GP.***

Corroborating these views is the information received from the HCWs that suggests that persons living with HIV are for one given inconsistent information on both the prevention and management of HIV CCMs. For example, several nurses mentioned that their patients complained that they did not have food to take their medication. However, one doctor said that food is not necessarily a determinant for taking medication and that some HCWs were not informed that patients should be encouraged to take their medication at all costs. Some of the responses of the HCWs are as follows:

"Sometimes lack of insight is one the challenging thing about dealing with HIV patients…when I used to work in district hospital they used to say how can I take my treatment when I don't have food…clinics don't teach people that you don't require food to take treatment, you can take ARVs on an empty stomach, it might make you nauseous but otherwise it does not cause anything…even most of the anti-hypertensive don't need to be taken with food."

Dr, EC.

"We encourage clients that maybe if she doesn't feel very well if she took the treatment in an empty stomach, she must take that treatment after food or with food so she can tolerate the treatment."

Professional Nurse, EC.

"Sometimes others shame, I am serving in the community that is faced with poverty, so sometimes it's hard for them to take medication due to lack of food."

Professional Nurse, GP.

4.12.1.2. Difficulties maintaining a healthy diet

In addition, another challenge threatening the ability of HIV positive adults to prevent other chronic conditions is the difficulties that they face with regards to maintaining a healthy diet. Chronic disease risk factors, such as smoking and alcohol use, are low among the adult participants living with HIV CCMs in this study. Where participants reported alcohol use, all said that consumption was done in moderation. However, prior to the second chronic disease diagnosis, some participants mentioned having an unhealthy diet consisting of fatty and non-nutritious foods. Other participants reported poor diet as a persistent challenge. The participants gave an account of their experiences as follows:

"I don't smoke but I do drink sometimes and to be honest the food I eat is not that good…They just tell you to exercise and eat healthy of which those things are hard to do for me especially because I cannot afford, financially I am struggling."

P8, EC.

"I don't smoke but drink alcohol sometimes…they complained at the clinic about my weight and the way I eat…I used to put too much salt on my food, and I am a fan of fatty food…even my weight escalates to 110kg and that is not healthy at all…whenever I feel hungry, I just eat and the food I eat I so fatty."

P9, EC.

"I only smoke snuff (smokeless tobacco) and I drink occasionally, maybe during birthday celebrations or Easter holidays."

P1, GP.

"I don't smoke, and I don't drink…my issue is food…I eat a lot of fat, foods like fat cakes and chips…and when I cook, I add a lot of cooking oil."

P2, GP.

"I do not smoke but I drink, sometimes… I don't even eat properly to be honest; I hardly have money to buy myself healthy foods so that I can eat the way I am supposed to…. since I started using pills for high blood, I am not gaining weight… I have remained on the same place always... I don't know whether it's because I am thinking too much or it's because I am not eating well but also the way I don't want these high blood pills I am thinking maybe they giving me stress, I don't like them at all."

P3, GP.

4.12.2. Treatment and Management Challenges

In 2016, South Africa adopted the universal test and treat strategy whereby all patients testing positive for HIV are immediately initiated on ART (Whiteside et al., 2015). However, a major challenge facing HCWs is that patients default from HIV treatment and, subsequently, from other chronic medication as well. Both HCWs and the adults living with HIV CCMs elaborated on several reasons and experiences that cause patients to discontinue treatment. Some of these factors are non-disclosure; polypharmacy, poor knowledge of treatments; constant movement of patients, socio-economic issues, and stigma.

"I think some of the challenges I encounter with PLWH is not taking treatment and not being honest. I think one feels better if they stop taking their treatment, so I think that is the most challenging thing…and when they are not taking their anti-hypertensive treatment and their diabetes medication, they won't be taking ARVs, why would they take ARVs?!'

Dr, EC.

4.12.2.1. Non-disclosure

The disclosure of HIV status is encouraged in HIV testing and counselling as it has implications on treatment adherence and the prevention of transmissions (Dessalegn et al., 2019). HCWs mentioned that most of their patients defaulted because of non-disclosure of their HIV sero-status to either their partners, family, peers and/or employers.

"Our challenge is patients not taking treatment…Some of them it is the disclosure with HIV because it will be difficult for you if you did not disclose to anyone around that you are HIV positive… you are not going to take treatment the way you are supposed to, then you end up having uncontrolled viral load and the blood pressure."

Professional Nurse 2, GP.

"People don't want to disclose, I think it is because of the stigma or whatever…they will even tell you that even the family haven't accepted

that they are HIV positive and now there is hypertension or diabetes so sometimes it's difficult…they are even too scared to disclose the status to their partners, parents and when not disclosing their status obviously adherence is going to fall."

Registered Nurse, GP.

"Some of them they default treatment because they don't want to come get their treatment because they don't want the stigma from society…they don't want to tell people that they are diagnosed with HIV."

Professional Nurse, EC.

Indeed, among the patients living with HIV CCMs, disclosure was a difficult and complicated process. It often took time for participants to trust someone enough to inform them about their HIV CCM status. Some participants reported that they had disclosed to their family members, who appeared to be most reliable. However, disclosure did not always occur face-to-face but rather over the phone or among the presence of an additional person (family member or close friend) who the participant trusted. During the interviews, disclosure was mostly understood to refer to the HIV status as opposed to the other chronic conditions. Among participants that were married or married but separated or had a boyfriend, disclosing to their (ex)partners was most difficult because they would question how they became infected. For participants that are employed, only one participant had disclosed to her employer. Others corroborated the HCWs viewpoint and expressed fear or being discriminated against and/or potentially fired from work. Below are extracts from the interviews with the patient participants.

"I haven't told my husband about my illness…there are already problems in our marriage, it will torment us even more…When I used to work, my manager knew about my status, but I wasn't neglected or discriminated in any type of way."

P7, EC.

"I told my family via the phone about my illnesses, they have started to support me…I haven't told my employer or friends because I will be judged and mocked…in my community, there are some judgemental people."

P8, EC.

"My entire family know about my status…it was easy to tell them also about my hypertension because my sister also has it and my other brother has sugar diabetes, so it was very easy disclosing…when it comes to boyfriends, we hardly even discuss our status, but I always ensure that I protect myself at all times by using a condom."

P1, GP.

4.12.2.2. Polypharmacy and Pill burden

In this study, polypharmacy was defined as the use of multiple medications, which is common for persons living with multi-morbidities (Masnoon et al., 2017). The standard treatment for

HIV involves the use of three drugs (WHO, 2010). These comprise of non-nucleoside reverse transcriptase inhibitor (NNRTIs) which consist of two drugs and tenofovir disoproxil and emtricitabine which are combined into a single drug (WHO, 2010). There are about up to sixty-six different types of antihypertensive drugs. The type and number of drugs that is given to a patient is often dependent on the level of elevation of their blood pressure (Chobanian et al., 2003). HCWs reported that taking multiple medications for HIV and other chronic conditions can be burden to patients, leading to treatment fatigue and causing them to default.

"Because there are too many tablets that one has to take, some they end up defaulting treatment because for example maybe for hypertension only, one has to take five tablets…and then there will be two for HIV…let's say the client is on second line treatment you see there will be too much pill burden for the client."

Professional Nurse, EC.

"Some patients have treatment fatigue; they would just get tired of taking treatment every day."

Professional Nurse, GP.

"When you start combining another condition, they become discouraged…I mean I was starting to comply with this one and now you are coming with this other one…when you start introducing something else and adding more pills, they feel like arg, I have lost the battle so why do I have to."

Registered Nurse, GP.

"I think pill burden is a problem for patients…for hypertension it depends how your high blood is elevated, for example I can start you on one drug or two or three drugs…so the fact that you have three drugs on top of the ARV drug…now taking four tablets in a day it's a lot for them. So, you find that some of them take the HIV drug only and say no the hypertension one I will see",

Professional Nurse, GP.

In the patient interviews, while some participants were diagnosed with HIV and Hypertension, the medication prescribed to them differed according to the severity of their condition, their immune response to the medication and other health indicators. As a result, some participants took fewer pills compared to others. Among those taking more than three pills, most reported medication fatigue and the constant monitoring of the time to take medication as burdensome. As suggested by the HCWs, at least two of the study participants reported defaulting from the hypertensive treatment because of the pill burden and side effects. The experiences of the patient participants are as follows:

"They are five…I take two for HIV and three for high blood…hey it is very hard…they are a lot and stressful to take…worse when I hear or see other people that taking 1 pill for HIV and probably less for

chronic…it worries me a lot, I just wonder what is so unique about my illnesses."

P8, EC.

"I wish I only drank ARVs… These pills (high blood) sometimes make me feel dizzy, I don't know if maybe I drink it at the wrong time or what, I become so dizzy such that I have decided to only drink it when I have a headache. I no longer drink it the way I am supposed to….. I think it's better maybe if they didn't give us pills but rather the medication for high blood is in a form of injection when you come, they just inject you."

P3, GP.

4.12.2.3. Treatment knowledge

Some issues were raised by the HCWs relating to patients not knowing the names of the treatments they are taking, especially for hypertension, which makes it difficult when patients move to a different location and need to explain to a new Healthcare worker about their treatment. In addition, some patients are reported to temporary default from taking their treatment because the missed their scheduled time for taking the medication.

"90% of patients, they do not know their treatment…The hypertensive and DM patients, they don't know their treatment…it's now easier with ARVs because there is regimen one and regimen two, so we found an easier way of asking them by saying do you take one tablet at night or do you take two, in the morning and evening…which is the difference between regimen one and two."

Dr 2, EC.

"Another issue is the time interval, so one might say I was supposed to take my pill at 8pm and it is now 9pm so I am not going to take my pill. I am going to take it the following day…problem is there is something called half-life of a drug so at 9pm you still have levels of the drug but therapeutic levels of a drug in your body overtime they are going to decrease."

Dr, EC.

"Our clients are moving a lot, today they will be here the next day they are in KZN…we tell clients that when they leave they should come and we give them a transfer letter but some do not follow that…usually what they do is that when they come to an institution they will say that it is my first time because client knows that she is supposed to be bringing a transfer letter."

Professional Nurse, EC.

Most of the adults living with HIV CCM reported to adhere to treatment. However, indeed most participants were unsure about the exact names of the treatment taken as noted in the following examples.

"I know the names of my medication but currently forgot the pronunciation, problem is recalling and pronouncing."

P10, EC.

"For HIV I know its ARVs for BP I can't recall the correct spelling."

P11, EC.

"I don't know their name; I just drink pills."

P9, EC.

4.12.2.4. Socio/Economic issues

Some of the socio-economic and political challenges in South Africa has been to transform the injustices made by the apartheid legacy. Several HCWs noted poverty and unemployment as one the core reasons to some patients defaulting from treatment because of an inability to afford, among others, clinic visits or the healthy lifestyle required for HIV management or the prevention of other chronic conditions.

"Some patients will tell you that I don't have food at home and don't even have money to go fetch that treatment at the hospital so mostly its social factors."

Dr 2, EC.

"Sometimes you find that the problem is with the employer, if they come to the clinic to get their treatment, they will be told no work no pay so it's tricky…they end up not knowing if they should go to work or come to the clinic."

Professional Nurse 1, GP.

About 50% of the adult participants sampled for the qualitative component of this study were unemployed and some dependent on social grants. While the remaining percentage was employed, some of these were informal work paying minimal salaries. Most mentioned that their financial ability did not match their financial responsibilities which for many included purchasing healthy foods to maintain the healthy lifestyle required for the management of their conditions, care for dependents which includes paying school fees and for some, transportation to health facilities for obtaining their medications. For example, some participants said:

"I am unemployed, so the problem is that I am not working. For someone to be living with these conditions and on the other hand not working it is a problem obviously… because even those pills you cannot just drink them when you have not yet eaten, you must eat before you can be able to drink pills…you must eat fruits and other things; all those things require money because even with this condition, we hear from doctors or nurses' advices that it is very important that we always eat lots of fruits and that is money."

P4, GP.

"I don't have much…once I get money from my children's grant and grant from my disabled brother who stays with me, I make sure I save and buy groceries in bulk so that we don't run out of food during the month."

P9, EC.

"I know one has to eat healthy at all times like you must always have fruits and vegetables…but it is a challenge since I am not working."

P1, GP.

4.12.2.5. Stigma

Almost all the adult participants living with HIV and hypertension mentioned to have experienced some form of stigma and/or discrimination because of being diagnosed with HIV CCMs. However, the stigma was often targeted at the HIV diagnosis as opposed to being hypertensive, diabetic or epileptic. The participants shared that aside from HIV, other chronic conditions were common, and it was common that many people in their communities would have them. One participant raised the point that people discriminated against persons with HIV because of how it is transmitted - through sexual intercourse. The existing stigma has caused some participants to fear disclosing, especially, their HIV status and to alienate themselves from the general community. The HCWs further mentioned that other patients preferred to take their ARV medication from clinics other than the ones in their community because of fear of stigma and discrimination. The experiences of the participants with regards to stigma are accounted for below.

"There is this cousin sister of mine staying at Jabulani Township, I went there to tell her about what I had found out and she said ooh! as though shocked but then we spoke and she advised me that you are like this, you need to take the treatment. She furthermore said I must buy myself food and eat. But then after I heard that she went around speaking about me behind my back. That really hurt me very bad, but I told myself oh well it's okay, it doesn't matter… You know what makes a person afraid is that when you tell someone that very someone goes outside and talk about you, it's how they say it and they laugh."

P2, GP.

"Most of our patients are taking medication where they are not staying, the people we are serving are not from this area most of them…they are from another community."

Professional Nurse, GP.

"At work I haven't disclosed my status and I am not planning to because they are very discriminative and judgmental…Even in the community there are people who discriminate and judge me, but I don't let that get to me."

P6, EC.

"It is still hard to talk about it in this community…I don't know whether we are illiterate or that we still have stigma."

P9, EC.

"HIV is a scary topic because it is said that it enters through sexual intercourse only, so it's difficult to talk about it. With high blood it's not scary you can easily talk about it anyhow…but it's scary when you have both conditions, people say that yah that person has serious problem… Where I stay, when you share your problems with someone, your problems will be all over, known by everyone…"

P3, GP

4.12.2.6. Stress

Stress appeared to be a major challenge for adults living with HIV CCMs in this study. While for some being diagnosed with HIV caused them a lot of stress, the stress reported was not always because of the HIV or additional chronic disease diagnosis but rather because of personal and financial circumstances. HCWs mentioned that poverty and unemployment was high in some of the communities and such factors were additional stressors among people living with HIV CCMs. Indeed, some participants reported that unemployment and poverty make it difficult for them to afford the purchase of the healthy food which is required to manage their conditions, and this stressed them out. Some were stressed because of a fear of death or falling ill and worried about who would take care of their dependents in the event of this occurrence. In most cases, the participants mentioned that their stress was the cause for their hypertension or uncontrolled blood pressure and that being stressed prevented them from being able to effectively manage both of their conditions. Below are extracts from the patient interviews:

"it's stressful, I sometimes sleep with an empty stomach, and I do not manage to take my pills on time."

P11, EC.

"It is not easy in that I am living in fear…I don't know if I sleep will I wake up or it will be the end of me…it is a stressful situation, but I have to be strong."

P7, EC.

"When I stress a lot even my high blood pressure increases…I have four children and they all girls…one is 20 years old and also HIV positive and sometimes she will go with her friends and visit her boyfriend…and I don't even know where she is right now…this is what stresses me. It's stress from thinking too much…the issue of unemployment, it's hard to live without a job and so on. On the side having people that are looking up to you and depending on you and you must support them, you see that thing."

P4, GP.

"Managing two conditions, it gives me problems yerr!!, it gives me stress, myself personally it gives me problems, I wish I only drank ARVs… I go to work even if I can feel that I am not well, my body is not well… I ask myself that if I don't go and I find that someone has taken my job what will I do… I force myself to, even if I feel that my body is struggling."

P3, GP.

4.12.2.7. Limited support programmes for HIV CCM management

There was inconsistent information shared regarding the availability of community support programmes to help patients living with both HIV and chronic conditions to manage their comorbidities. The HCWs reported that support groups in the form of adherence clubs are the most common form of support provided to adults living with HIV and other chronic conditions such as hypertension. Even so, most were focused on HIV rather than other chronic conditions. The HCWs said social workers, community workers and health promoters, often from non-governmental organisations (NGOs), take up the role of supporting clinics with enduring treatment adherence, tracing defaulted patients, and providing psychosocial support to diagnosed patients. Some of the extracts from the HCWs are as follows:

"We have a WhatsApp group for most of them to give them an allowance to ask whatever question from me or the counsellors…the are also clubs for people that are taking the treatment…the clubs are not only for people who are HIV, they are for everyone who has chronic but stable and they don't have to see the professional every now and then…when I say stable I mean the blood pressure is controlled."

Professional Nurse, GP.

"We have support groups…the groups they help with counselling the person when they join, helping with some few meals they try to advise the patients to try look for a job…but they are more concentrated on HIV."

Professional Nurse, GP.

"We have clubs, when a client in on treatment for a certain period of time they join clubs…the clubs don't segregate to say hypertension, TB or whatever."

Professional Nurse, GP.

"We get support from NGOs…they come to the clinic because government doesn't have staff…and they assist with things like tracing defaulting patients."

Professional Nurse, EC.

Across both the Eastern Cape and Gauteng provinces, the patient participants reported that there were no consolidated or formal programmes that addressed or supported persons living with HIV CCMs, at least at the primary care level. Only one participant mentioned that she was part of a support group that provided holistic chronic education. All other study participants

showed disappointment in the lack of additional support; in the form of counsellors and social workers; to provide care to persons living with more than one chronic condition. Where participants benefitted from the services provided by social workers, it was as the HCWs mentioned, services provided by NGOs which were often inconsistent because as the NGOs completed their funding term, they would terminate their provision of services. An account from some of the participants' is as follows:

"We just get our medication and go home…we do not have support programmes that help us to cope with mental and stress of having these conditions."

P9, EC.

"There is no such program here that helps people with comorbidities to manage…maybe it's still coming but not yet."

P2, GP.

"We used to have counsellors, but they are no longer there…Yoh personally, even if it it's any kind of support you can assist me with just so I can at least use one thing only, that I should only focus on the HIV and this high blood to go down and completely disappear."

P3, GP.

"The only thing I know is that they give us pills and ask us how the pills are treating us or during the night do you sweat and how do you feel and so on. That's all, there is nothing else besides that."

P4, GP.

4.12.3. Access to Healthcare

4.12.3.1. Resource unavailability

Lack of adequate staffing is a major hurdle to HCWs in public healthcare facilities. This has implications on the HCW's ability to provide holistic and attentive care to patients with HIV CCMs. In at least one rural area, shortage of medicine was also a concern.

"Sometimes the facility itself would be packed, so meaning that you don't really have enough time to spend with one patient, you have to rush the queue…another thing sometimes we have problems with shortage of drugs especially chronic medication like for hypertension and diabetes."

Professional Nurse, EC.

"The problem that we have is staff shortages, that's the problem…I think if we can have enough staff, I think health providers can do everything."

Professional Nurse, EC.

"Staffing in the main concern… we are short-staffed…and we end up being worked out because of seeing all of these conditions."

Professional Nurse 1, GP.

Overall, most of the patient participants interviewed were satisfied with the treatment and care provided by their healthcare workers upon arrival and during consultation at the clinic. From their perspectives, healthcare workers often displayed a positive attitude and a willingness to assist patients. While there were no reports of shortages or medications, one participant complained about the slow speed in service delivery which reflects the issue around staff shortages that were mentioned by HCWs. For example,

"To us it seems as though they are just slow, but they are not slow it's just that they are short staffed."

P2, GP.

"As for me I have never experienced any bad treatment from this clinic. I don't want to lie…the nurses here are very calm I don't want to lie… However, the only thing that is a problem is the fact that the nurses can be very slow sometimes when rendering their services."

P5, GP.

4.12.3.2. Integration of chronic care in PHC

In 2011, South Africa moved towards adapting an integrated chronic diseases management model that addresses the double burden of HIV/AIDS and NCDs at a primary healthcare level (Ameh et al., 2016). However, training on the model remains suboptimal and implementation requirements are not standardized across at least the two geographical sites, remains unclear. For example, there were some clinics that integrated the treatment and care provided to patients living with HIV and hypertension however there were reports from other HCWs that patients with HIV and hypertension Comorbidity required that each condition be treated separately. Some examples of the extracts from the interviews are as follows:

"Somehow chronic care is not yet too much integrated in the government sector because I remember asking another patient why she had another date for another treatment…you find one condition is handled by the other and one also handled by the other."

Dr, EC.

"We mix them, we don't remove the HIV clients this side, TB this side and Hypertension this side, we don't classify them according to their diagnosis…we put them all in one place, they all have the same files, the same appointment cards…it is only the clinicians who know what they are dealing with when they open the file."

Professional Nurse, GP.

"Let me be honest with you, when I was working at Zwide clinic I had just come from working in a hospital, so at the hospital I was working at

medical and didn't know much about what is going on in the primary health care and I did not get training like specific to co-morbidities…I was just thrown in the deep end."

Professional/Triage Nurse, EC.

According to the patients, the integration of HIV and Chronic disease care is taking place insofar as ensuring that all chronic medications are administered by one nurse and conducting routine testing for high blood pressure among HIV positive persons. Only one study participant reported that she received her HIV and hypertensive treatment from separate facilities while another participant raised concern over the separation of ques for patients attending HIV treatment and care and those receiving care for other conditions at the health facility that she was attending. Although these findings are minimal and cannot be generalizable, this raises concern over how well and comprehensive the ICDM is being adopted and implemented in health systems in South Africa. Some of the experiences of participants with regards to the chronic care integration is as follows:

"I get my pills from one nurse…I had a problem with the way the ques are formed. People with HIV had their own line and other people who came to the clinic for different issues had their own lines…that puzzled me a lot."

P10, EC.

"I get my hypertensive medication and ARVs from two different nurses…I am travelling in between different institutions now, because I was transferred to Bara because of my hypertension. And it got controlled, so a month ago when I went for check-up it was down. So, I was transferred back to Bheki Mlangeni for my Anti-Natal Care (ANC) and hypertension. And then for my ARV's I go to Chiawelo clinic…I would really love to go to one facility for everything."

P12, GP.

"I get all my pills for both conditions from the same nurse…When I started treatment, whenever I come here, we are pumped that is when they told me that I have high blood."

P4, GP.

4.12.3.3. Long distance travel to the clinics

Another important issue affecting access to treatment was the long travel distance to the clinics. Some of the patient participants in the rural parts of Eastern Cape mentioned that health facilities are not located within close proximities to their residential location. Most of these participants reported having to walk long distances or requiring transportation to access the nearest clinic. On the contrary, in Gauteng province where participants from peri-urban regions were sampled, clinics and hospitals are easily accessible. However, the healthcare providers mentioned that some patients in urban and rural areas still preferred to travel long

distances to their clinic of preference because of fear of discrimination and stigma within their communities. For example, some of the participants said:

"Another challenge would be travelling from home to the facility, they walk long distances in rural areas."

Professional Nurse, EC.

"The clinic is far, worse there are no forms of transportation here. We are in rural areas. It is not a walkable distance and I have a leg problem."

P10, EC.

"It is far because I have to take a taxi…I cannot afford and sometimes I don't have money to go to the clinic."

P8, EC.

"Another difficult thing is the stigma, they change clinics…I'll find that I'm now having a patient from Soweto coming to Johannesburg…then I'm asking the patient, but you spend +-R70 to come to the clinic, why can't you go to the clinic nearer to you? They will tell you that the community is talking, they know that I am sick and all that."

Professional Nurse, GP.

"Most of our patients are taking medication where they are not staying, the people we are serving are not from this area most of them…they are from another community."

Professional Nurse, GP

CHAPTER FIVE: DISCUSSION

5.1. Introduction

In this chapter, the major findings from the study and in line with the study objectives are consolidated and presented. The chapter firstly reiterates the research problem and discusses the outcomes of the cox proportional methods applied in this research paper to determine how long it takes for adults living with HIV to develop hypertension. Thereafter, the factors that contribute to the development of the Comorbidity of HIV and hypertension are evaluated in review of existing literature from the sub-Saharan African region. Thirdly, the findings from the IDIs on the challenges pertaining to prevention, treatment, and access to healthcare that are experienced by the population of adults living with HIV CCMs are again reviewed to assess what was congruent or conflicting with the literature. Finally, the study hypotheses, theoretical and conceptual frameworks adopted earlier in the study are evaluated for relevance. The chapter concludes with a discussion of the study's main contribution to the existing body of knowledge and ends with a summary of the limitations and strengths of the research.

5.2. Research Findings

5.2.1. Time to development of chronic conditions among adults living with HIV in South Africa

Hypertension was the most prevalent (10.5%) chronic condition among adults living with HIV in the quantitative component of this study. This study retrospectively assessed the time taken to the development of hypertension among adults living with HIV. The assessment was conducted quantitatively and the results from the analysis show that the risk of developing HIV and hypertension Comorbidity is highest between the ages 30 – 46 years. In other words, an adult diagnosed with HIV at the age of 18 is likely to become at risk of hypertension from the age of 30 and will remain at risk for over 15 proceeding years. Findings from the qualitative research also revealed that PLWH were most affected by hypertension among all chronic conditions. In addition, the study found that HCWs and patients show that lack of adequate information on the prevention of HIV CCMs, polypharmacy, stigma, unemployment, and long travel distance to the health facility are barriers for the prevention and management of HIV CCMs for patients.

Both the quantitative and qualitative findings observed in this study align with existing literature that shows a growing risk of hypertension and diabetes among adults living with HIV in South Africa and across the globe (Chhoun et al., 2017; Nlooto, 2017; Rodríguez-Arbolí et al., 2017). Time to the development of hypertension among adults living with HIV was assessed using age. Age was used as the scale to build adequate time inferences. Firstly, because age is associated with survival and acts as a confounder in the development of chronic conditions, such as high blood pressure. While some standard statistical methods would normally use time in years adjusted and/ or stratify by age, the effect of the different ages on the outcome is at times missed. To overcome these challenges, age as the time scale takes into account the effect of age on the development of the HIV CCMs while automatically adjusting for its confounding effect (Lamarca et al., 1998). Therefore, the development of HIV and hypertension Comorbidity in this study was based on the individual age of the participants and not on their duration in the study.

In the assessment of time to diagnosis, the results at waves 3 and 5 indicate that the risk for developing HIV and hypertension Comorbidity was highest between the ages 30 – 46 years. This is an important finding because past research have found that the time taken before HIV positive persons are diagnosed with a second chronic condition was unclear (D. J. Kim et al., 2012; H. Lalkhen & Mash, 2015). The limited evidence available has been from high income countries such as Canada where in one longitudinal study following PLWH over a six year period, almost 30% of participants developed hypertension within that period (Okeke et al., 2016). One other study conducted in Cameroon, reported that 61% of HIV infected patients that were on ART for no less than 34 months developed CVD risk factors such as hypertension (Dimala et al., 2018a).

The findings in this study are important because they provide evidence on the time to hypertension development. The findings can be contextualised to the SSA setting and also show length of years PLWH have been diagnosed with hypertension. In the quantitative study, the time to hypertension diagnosis was about 15 years for adults who would have been diagnosed with at the age of 18. In the qualitative study, while some participant participants developed hypertension after 4 years, some participants were living with this Comorbidity for as long as thirteen years. Reasons adduced include duration of HIV of infection and initiation to ART. For example, prior research has reported that hypertension in PLWH develops between 2 and 5 years after ART initiation (Calò et al., 2013). While ART variable was unkown in the NIDS survey, all of the participants in the qualitative component of the study were on ART which aligns to the short time taken to hypertension develop in the study by Calo et al.,

2013. In light of these findings, it is also important to mention that the date of HIV infection for participants in this study was unknown.

Research shows that the risk of chronic conditions is elevated as people grow older, irrespective of HIV status (Balderson et al., 2013; Benzekri et al., 2018; Chireshe et al., 2019; Wing, 2017). In the qualitative interviews with adults living with HIV and either hypertension or diabetes, the prevalence was highest among the 46 – 50 age group compared to the younger age groups (<40 years). The quantitative results in this study present a new age of risk (from age 30) for the Comorbidity of HIV and hypertension which has not been included in previous studies. For example, past studies such as in the study by Balderson et al (2013), PLWH above the age of 50 had increased odds of developing high blood pressure (Balderson et al., 2013). In Zimbabwe, the risk of hypertension in PLWH has recently been found to be higher among adults over the age of 40 (Chireshe et al., 2019). Research from Uganda has also reported an increased risk of hypertension among men living with HIV above the age of 40 compared to HIV positive women in the 30 -39 age group (Okello et al., 2015). Corroborating these findings is a study also from South Africa that confirms that adults aged 40 years and above are at greater risk of hypertension(van Heerden et al., 2017).

The present study is congruent with this existing literature insofar as the age of 40 falling within the inclusion criteria for risk of hypertension diagnosis noted in previous studies. However, the results in this study suggest that people living with HIV in SA are at risk of hypertension Comorbidity at least 10 years before the age postulated by existing research. Our study is the first to draw attention to the increased risk of hypertension among the younger age groups (≥30 years) living with HIV in South Africa, which is an important finding for literature in sub-Saharan Africa because it shows the importance for preventative measures for hypertension to be extended to youth as well. Additionally, this is of notable importance given that young people, and particularly adolescent girls and young women (15 – 24 years) are the most affected by HIV/AIDS in the sub-Saharan region (AVERT, 2019a).

In 2018, new HIV infections among young people in South Africa were 69 000 and 25 000 among women and men, respectively (AVERT, 2019a). With hypertension risk beginning at the age of 30 for people living with HIV, it is expected that there will be an increased young population that is reliant on the already burdened public health sector for Comorbidity care, alongside other social and economic stressors that face people living with HIV comorbidities. In a country like South Africa where a third (35%) of the population is made up of youth (15 - 34 years), comorbidities threaten to decrease the overall quality of life and increase morbidity and mortality among this young population group (K. Kim et al., 2013).

The increased odds of hypertension in earlier ages of persons living with HIV have been observed in studies from developed countries. For example, Chatterton-Kirchmeier et al. (2015) found an increased prevalence (19.6%) of hypertension among children and adolescents living with HIV that were aged 2–17 years old (Chatterton-Kirchmeier et al., 2015). However, these findings were contradicted in the study by Mehta et al. (2016) which did not find hypertension among its sample of HIV perinatal infected adolescents (Mehta et al., 2016). Our findings of an increased risk of hypertension starting from the age of 30 is similar to research by Mehta et al (2016) in that the study found young adults aged 18 – 29 with perinatal-acquired HIV had increased prevalence (23%) of hypertension as compared to those that had acquired HIV at a later stage in life (10%) (Mehta et al., 2016). The difference between our findings and this study is that our data did not give us the liberty to determine whether the HIV infection among our study sample was acquired perinatal.

Some research has pointed out that the reason for the increased risk of hypertension among young adults could be because young adults infected with HIV have the same immunologic profiles as older HIV-uninfected adults (Kalayjian et al., 2003). However, the epidemiology and disease progression of hypertension in PLWH was beyond the scope of the research presented in this report.

Interestingly, prior research has also reported that hypertension in PLWH develops between 2 and 5 years after ART initiation (Calò et al., 2013). In South Africa, the highest risk age of HIV is between 15 -24 for women and 25 – 49 years for males (AVERT, 2019a; M. Mabaso et al., 2019). Hypothetically, males and women who acquire HIV at the age of 15 and 25, will develop hypertension at least by the age of 17 and 27, respectively, if they are on ART. Given the findings by Masenga et al. (2019), the early development of hypertension is still expected among ART naïve persons (Masenga et al., 2019). One of the limiting factors of the NID survey is that it did not have a variable that assessed ART use or adherence. In other words, it is unknown whether the study sample included in this study were on treatment or ART naïve. However, to make up for this shortfall, in the qualitative study, ART use was an inclusion criteria and all persons enrolled for the qualitative interviews were on ART. The findings from the qualitative interviews reported a similar prevalence of hypertension among patients on ART, suggesting that indeed hypertension could be one of the factors responsible for the hypertension Comorbidity.

5.2.2. Characteristics associated with the time to development of hypertension among adults living with HIV in South Africa

Much of the risk of hypertension among people living with HIV has been associated with an increase in age, the use of ARV drugs and inflammation caused by the HI virus (Deeks, Tracy, et al., 2013; Sarkar & Brown, 2000). There has been a contestation in literature regarding the demographic and socio-economic characteristics that are linked with the development of chronic conditions among PLWH (Chireshe et al., 2019; Hopkins et al., 2019). Nonetheless, the effect of an array of demographic and socio-economic factors, as conceptualised in the framework (Figure 2.4), were assessed in this study to generate new conclusions on the associations of these factors on, particularly, the development of hypertension in PLWH.

***Non-significant but important characteristics*:** This study did not find significant associations in the adjusted cox models between any of the socio-demographic and economic characteristics (sex, race, marital status, place of residence, household income and level of education) and the development of HIV and hypertension Comorbidity. The reason for the non-significance in the results can be related to the categorization of the variables into binary variables to increase the number of cases in each category. However, some of these outcomes were expected as there has been arguments in literature about the influence of these factors on chronic disease development in PLWH. For example, a recent study in Ethiopia observed that gender was not significantly associated with chronic disease in PLWH (Woldesemayat, 2020). In South Africa, Chireshe at al. (2019) found that hypertension in PLWH did not vary by place of residence (Chireshe et al., 2019). Studies with larger datasets are therefore important to assess the factors.

While race has not been explicitly found to have an impact on chronic disease development, the difference in the chronic risk profile between various ethnic groups have made the prevalence of chronic diseases to seem higher among some races compared to others. A study from London found that white males living with HIV were more likely to have comorbidities, particularly CVD (Lorenc et al., 2014). This contradicts other studies that have found hypertension to be significantly higher among Blacks (Kurian & Cardarelli, 2007). The increased risk of CVDs, including hypertension among whites and blacks found in previous studies could be related to years of smoking (Egbe et al., 2019; Shuter et al., 2014). However, this study did not find an association between race and HIV and hypertension Comorbidity possibly because of the low smoking prevalence reported. Similar to the findings in this paper, most studies across Africa did not find a significant association between marital status and HIV CCMs (Hammami et al., 2011; Macia et al., 2012; Peltzer & Phaswana-Mafuya, 2013).

Given these findings, all PLWH presenting with chronic risk factors should benefit from chronic disease programmes irrespective of their race, gender, place of residence, or marital status.

In the unadjusted model, a significant association was found between religion and the development of hypertension in PLWH. However, this relationship became insignificant in the adjusted model. It is, therefore, worth noting that while it is possible that this effect was confounded by other demographic variables, this outcome is interesting because of two reasons. Firstly, because while most studies have explored the role of religion on HIV prevention (Mash & Mash, 2013; Ochillo et al., 2017; Zou et al., 2009) and the religiosity of people infected with HIV (Arrey et al., 2016; Szaflarski, 2013), the pathways through which religious beliefs affects health have not been widely studied (Cozier et al., 2018).

The extensive work by Pargament et al. (1998; 2000; 2004) has found that religion is used as a coping strategy particularly in stressful circumstances such as coping with the diagnosis of disease and illness, including HIV (Arrey et al., 2016; Pargament et al., 1998, 2000, 2004; Szaflarski, 2013). Indeed, these findings were corroborated by some participants living with HIV CCMs in the qualitative research of this study who spoke of 'God' as their source of encouragement and that they had learnt to be content with living with HIV and other comorbidities because it was the will of God. However, the study by Cozier at al., (2018) reported an increased incidence of hypertension among women who scored the highest religious scores. Similarly, a study by Buck et al (2009) found that prayer was associated with an increased risk of hypertension. Therefore, while the quantitative results in this study did not observe a significant relationship between religion and the risk of hypertension among PLWH, the dynamics of religion on health warrant further investigation.

The non-significant relationship found between the socio-economic variables and the development of hypertension among PLWH could be owed to the small sample size which reduced the coding of variables to be binary. For example, level of education was coded as 'no education' or 'some education'. This is an important limitation because the robust differences in the levels and their distinctive effect of the outcome are not accounted for. Alternatively, it is possible that the variables used (household income; employment status) were not an accurate measure of financial or socio-economic status (Daya et al., 2016). Interestingly in the qualitative findings, none of the participants had tertiary education and most of the sample HIV infected adults living diagnosed with hypertension were challenged with issues of unemployment and financial difficulties. While unemployment, low household income or lack of education may not necessarily lead to the development of chronic disease in PLWH, these factors make the management of HIV chronic comorbidities difficult as revealed in the

qualitative sub-study. Therefore, socio-economic empowerment for PLWH should form part of HIV policy priorities as the lack of affects disease management, particularly for those living with HIV comorbidities.

Nonetheless, the study setting for the qualitative component of this research comprised of participants mostly from rural and peri-urban regions of South Africa. In South Africa, economic inequality remains a problem and there are significant differences between the rich and the poor. This is worth noting because the socio-economic challenges experienced by persons living with HIV CCMs and residing in rural and peri-urban regions are likely to be non-existence or different from the challenges experienced by PLWH and HIV CCMs who reside in more affluent communities of South Africa. That said, contextual differences are important and warrant further analysis in future research on HIV chronic comorbidities. This extended research can conduct a comparative analysis of the prevention and management experiences of HIV CCMs among diagnosed patients in rural areas vs urban regions.

This study found a borderline significance (p=0.057) between perceived health status and hypertension Comorbidity in both the adjusted and unadjusted cox models. Although not significant, this finding is important because research shows that poor perceived health is one of the determinants of health seeking behaviour (M. L. H. Mabaso et al., 2018). Interestingly in the qualitative findings, most adults living with the Comorbidity of HIV and hypertension complained of being unhealthy. Reasons adduced to this included stress, struggling to manage their Comorbidity and unhealthy diets resulting from a lack of money to buy healthy food. Studies across Botswana, Tanzania and Uganda have shown that food insecurity, exacerbated by financial difficulties, negatively impacts ART adherence (Bukenya et al., 2019; Tuller et al., 2010; Weiser et al., 2010). The health seeking behaviour of this population sample was not assessed. However, the 'poor health' among people living with HIV comorbidities has been observed in China. Zhu et al (2017) and the authors found that the Comorbidity of HIV and TB was significantly associated with poor perceived health status and mental ill-health (Zhu et al., 2017).

An important evaluation that this study draws attention to is the possibility that in contexts where PLWH and CCMs are not challenged by poor health or the perception thereof, then prevention and management of HIV CCMs may easier. However, to make this conclusion, it is again important to assess contextual differences between the rich and the poor.

Several studies have found an association between tobacco and alcohol use and CVD, COPD, and stroke even among PLWH (Egbe et al., 2019; Shuter et al., 2014). This important relationship was not found in this study. Possible reasons could be the under-reporting of

smoking and alcohol given that the NIDS relied on self-reported accounts of both smoking and alcohol use. Additionally, in the qualitative assessments, some participants reported that they smoked snuff/smokeless tobacco which was not assessed in the quantitative component. Other studies in South Africa have used urine cotinine and carbon monoxide tests to provide accurate measures of smoking status among PLWH (Egbe et al., 2019). For example, a study conducted in the North West province of South Africa among PLWH found a higher prevalence of smoking using exhaled carbon monoxide and urine cotinine tests (28%) compared to the self-reported results (25%) (Elf et al., 2018). National surveys, including the NID which is longitudinal, need to adapt strategies that ensure accuracy in the reporting of smoking and alcohol status. Studies across Ethiopia, Tanzania and Uganda have found smoking and alcohol use to be significantly associated with hypertension among HIV infected persons (Kavishe et al., 2015). Given the close relationship between tobacco and alcohol use, innovative strategies to achieve smoking cessation among PLWH should be enforced as the impact of these factors on chronic disease development is widely known.

While there was no significant association observed in the quantitative analysis between exercise, diet, and the development of hypertension among adults living with HIV, the majority of the participants in the qualitative study reported to exercise regularly. Exercise included walks to the clinic or shop. The type of exercise measured in the quantitative study remains unclear. Given that physical inactivity has been cited as a major risk factor for chronic disease (Hemkens & Bucher, 2014), both the intensity and frequency of exercise should be accounted for in future survey measurements. Several of the participants in the qualitative component of this research were concerned about their diet, some reporting that they cannot afford the healthy foods including fruits and vegetables on a regular basis. This observation links to the importance of providing socio-economic reforms for PLWH that was earlier discussed in this paper.

5.2.3. Challenges with prevention, treatment, and management of HIV chronic co-morbidities

Persons living with HIV CCMs have different health needs compared to the general HIV positive population. The final objective of this paper was to understand the challenges faced by adults living with HIV CCMs. Several of these challenges (unemployment, financial

difficulties, stress etc.) have been discussed in review of the quantitative findings. However, other important challenges have been noted.

***Prevention of HIV CCMs*:** The HIV positive participants in this study reported a lack of sufficient information on ways to prevent the occurrence of chronic conditions. Studies have shown that effective communication between healthcare providers and patients leads to favourable health outcomes; and the inverse is expected where communication is poor (Tiwary et al., 2019). In fact, one study found that communication problems were responsible for the increase in preventable adverse effects among its participants (Bartlett et al., 2008). While it is important for healthcare providers to provide patients with holistic information on chronic disease prevention regularly, several communication challenges including language barriers and insufficient time to spend with one patient continue to exist in South Africa (Hunter-Adams & Rother, 2017; Kelly et al., 2019). Indeed, the healthcare providers interviewed in this study expressed that because of the limited staffing and high patient turnover, they lacked the capacity to spend sufficient time informing patients living with HIV about chronic diseases prevention. Even so, the onus of sourcing information on the prevention of chronic conditions also lies upon the patients themselves. A number of studies have shown that people who are educated are more likely to learn about healthy behaviours (Goldman & Smith, 2002; Williams et al., 1998). The disadvantage observed in both the quantitative and qualitative findings of this research has been that levels of education are suboptimal. Evidently, more work needs to be done on establishing a viable patient-centred approach especially for persons with HIV CCMs. This could include using volunteers to give lessons on chronic disease prevention while patients are still in the queues, prior to consultation with the physicians.

***Access to treatment and management of HIV CCMs*:** Long travel distance to the clinic was one of the major challenges affecting treatment access, particularly among participants from rural areas of South Africa. A previous study from South Africa found that PLWH in rural areas were less likely to access treatment (Wilson & Blower, 2007). This finding corroborates with several other studies across sub-Saharan Africa that have reported lack of transportation and long distance to the clinic as important barriers to HIV treatment (Alegana et al., 2012; Shubber et al., 2016; Sileo et al., 2019). In a retrospective cohort study of ART patients in Malawi, the odds of loss-to-follow-up were higher among patients who resided more than 8km from a health facility compared to those that travelled a lesser distance (Bilinski et al., 2017). The challenges with regards to access to healthcare services are not surprising because this study recruited participants from rural and peri-urban regions, which are still undergoing some socio-economic development and reforms including making resources more accessible. It is worth

noting thereof that the same challenges may be lessened in more urban and affluent communities.

In late 2020, a study in South Africa launched a clinical trial to shift post-hospital care for PLWH from the clinic to the home through providing clinical home visits, reconciling medications, assessing for food insecurity and providing overall psychosocial support (NIH, 2020). The results of this trial are expected in late 2022. Irrespective of context, and depending on the outcomes of these findings and the availability of resources, the National Department of Health can adopt the same strategy to provide care for patients with HIV CCMs, particularly from rural areas.

***Lack of Chronic care integration in PHC*:** The ICDM introduced by the South African National Department of Health in 2011 was designed to provide an innovative HIV treatment program that includes care for NCDs in order to improve the quality of chronic disease care and health outcomes of people with chronic conditions (Department of Health, 2012). Not many explicit complaints over the integration of chronic care were reported by the patient participants. However, few concerns were raised over PLWH having separate queues from other patients attending the clinic. This concern has been noted in another study in South Africa where HIV positive participants felt it was stigmatising to join specific queues at health facilities because it was easy for people to suspect they that they were HIV positive (Shamu et al., 2019). However, this is possibly done to mitigate the challenge of having HIV positive clients join long general queues that could take took up to a full day to initiate ART (Shamu et al., 2019). Even so, specific outcomes of the ICDM model are to facility reorganization, clinical management support, assisted self-management as well as health promotion and population screening (see Figure 2.3) (Department of Health, 2012).

Health providers in this study have reported challenges with shortages of staff and lack of training on the delivery of this model. These factors affect the operational efficiency of the facility as they could mean longer waiting times for patients while insufficient training negatively impacts the clinical management support by compromising the ability of clinicians to provide adequate care to people living with chronic comorbidities (Asmal & Mahomed, 2016). In addition, the issues of unemployment, financial difficulties, long travel distance to a health facility and food insecurity raised by participants in the qualitative component of this study all threaten the 'assisted self-management' aspect of the model insofar as chronic disease patients being unable to effectively take responsibility of their health because of these challenges. This is corroborated by a recent study conducted by Bosire (2020) on patient's experience of HIV and Diabetes Comorbidity care in South African health facilities (Bosire,

2020). In this study, socio-economic factors such as poverty, unaffordable travel costs to health facilities, and food insecurity were reported to affect the self-management of chronic comorbidities (Bosire, 2020).

Another important challenge pertaining to the management of HIV CCMs raised in this paper includes fatigue over the pill burden of taking HIV and other chronic medication. Several studies have mentioned polypharmacy as a risk factor for non-adherence and medication among PLWH (Krentz et al., 2012; Zhou et al., 2014). Simpler treatment regimens are, therefore, necessary for patients with HIV CCMs (Monroe et al., 2013). Given that this study also found poor knowledge of treatments among the participants living with HIV CCMs, targeted education on chronic diseases is required.

Lastly, the perpetuating HIV stigma within communities and at the workplace have made it difficult for some patients to disclose their HIV status. Of interest is that people living with HIV CCMs were more comfortable with disclosure of their hypertensive status than they were of HIV or the two conditions jointly. Research shows that non-disclosure is another risk factor for non-adherence and affects mental health (Daskalopoulou et al., 2017). A study in South Africa found that some participants found it difficult to attend health facilities for collection of their ARVs because of fear of being discriminated and being seen by people they knew (Kheswa, 2017). It is, therefore, evident that the ICDM needs to be continuously evaluated and strengthened further to address some these challenges.

5.2.4. Review and Test of Study Hypotheses

This study hypothesized that an HIV positive adult is at higher risk of developing a chronic Comorbidity between the ages of 40 - 45 years old. This assumption was based on evidence from an array of studies that have found that chronic diseases in PLWH are significantly increased after the age of 40 (Akanbi et al., 2015; Chireshe et al., 2019; Getahun et al., 2020; Gupte et al., 2017). In these studies, PLWH were at highest risk of hypertension. Indeed, this study corroborated these finding in that it also found that PLWH were at highest risk for hypertension than any of the other chronic (diabetes, heart problems, stroke, and cancer) proposed. However, the Kaplan Meier survival estimates have shown that adults living with HIV are at risk of hypertension from the age of 30 (Chapter 4; sections 4.5-4.6;4.10-4.11). The new assumption is, therefore, that chronic conditions can affect PLWH from an early age. This is possibly owing to the epidemiology of the HI virus and the effect of ART (Barbaro &

Iacobellis, 2009; Maciel et al., 2018a; Negin et al., 2012; Sarkar & Brown, 2000; Yang et al., 2019b).

The second hypothesis of this study is that demographic, socio-economic, and health characteristics are associated with the time (age) in which an HIV positive adult develops a second chronic condition. Controlling for age, literature has contested the effect of factors such as place of residence, sex, marital status, and others on chronic disease development in PLWH (Hammami et al., 2011; Peltzer & Phaswana-Mafuya, 2013; Tuoyire & Ayetey, 2019; Winkleby et al., 1998). However, it has been clear that chronic risk factors such as smoking, alcohol, physical inactivity, and poor diet had an effect on the development of chronic conditions even among PLWH (Hemkens & Bucher, 2014). Results from the cox proportional hazard model found that none of the demographic, socio-economic and health characteristics were significantly ($p<0.005$) associated with hypertension development among PLWH. influenced the development of hypertension among the HIV positive sample. This hypothesis cannot be confirmed because the effect of other important health characteristics, such as BMI and the use of other drugs, were not assessed.

The last hypothesis in this study is that an inability to prevent and access holistic, integrated healthcare increases the risk for HIV positive adults to develop co-morbidities and affects the management of HIV chronic comorbidities. This hypothesis is confirmed by the challenges experienced by both adults living with HIV chronic comorbidities and the healthcare providers that are responsible for the treatment and care of these patient. Evidently, barriers to preventing chronic diseases included lack of adequate information provided to persons living with HIV. While strategies such as the ICDM model are in place in to provide efficient care to persons living with HIV CCMs in South Africa, challenges with limited staff capacity and lack of training affected the care provided. This study found that the management of HIV CCMs is not only affected by the ability to receive integrated treatment and care but there were deep seated socio-economic issues that threatened treatment adherence.

5.2.5. Re-evaluation of Theoretical and Conceptual Frameworks

This study developed a conceptual framework adapted from the Social Determinants of Health (SDH) Theory, The Vector Model of Complexity, and the Integrated Chronic Care Disease Model (Asmal & Mahomed, 2016; Safford et al., 2007; WHO, 2017). The SDH Theory proposed to understand the effect which socio-economic factors affect the health behaviour and outcomes (WHO, 2017). The Vector Model of Complexity explained the interdependent

relationship of biological, socio-economic, and health factors that influence overall health, and more importantly, gave consideration to the development comorbidities (Safford et al., 2007). Finally, the ICDM model sought to provide a patient centred approach for the care of persons with HIV and other chronic conditions (Asmal & Mahomed, 2016). Jointly, these theories and models were used to design a framework that shows the relationship of various demographic, socio-economic and health factors, and their influence on the development of HIV chronic conditions (Figure 2.4).

A major strength of this framework is that it proposed an exhaustive list of demographic, socio-economic, and health factors that could potentially have an impact on the development of a number of chronic conditions (hypertension, diabetes, heart problems, COPD, Cancer and Stroke) in PLWH. This study assessed the effect of each of these determinants individually to ascertain which held a significant association with PLWH developing an additional chronic condition. The proposed determinants can also be used to assess the development of other health outcomes.

Additionally, the framework provided a clear pathway in which these factors lead to HIV CCMs. It showed the relationship between socio-economic factors and access to healthcare and the role of health system in providing care to persons with HIV comorbidities through various strategies proposed by the ICDM model.

Some limitations are, however, noted from adopting this framework. Firstly, an important chronic risk factor, such as BMI, was not conceptualised. Several studies have shown increased BMI to be associated with metabolic syndrome, high blood pressure, COPD and other cardiovascular diseases (Lalloo et al., 2016; Mugisha et al., 2016a; Osoti et al., 2018; Pefura-Yone et al., 2015; Saeed et al., 2013; Steenkamp et al., 2014). The insignificant association observed particularly among the health characteristics (exercise and diet) may have been dependent on the availability of this variable.

Secondly, not all chronic conditions were assessed and included. For example, the development of COPD in PLWH was not explored in this study because this variable was not available in the NIDS dataset. This potentially leads us to miss understanding the magnitude of the Comorbidity of HIV and COPD in South Africa. Individual income was also not included even though it may serve as a better measurement of financial status than household income. The effect of use of other drugs (aside from alcohol and tobacco) on HIV CCM development was also not assessed. Finally, and considering the findings in this study, this framework did not illustrate the importance of age as a variable to assess time to HIV Comorbidity diagnosis.

Given these shortcomings, and in consideration of the results of this study, a revised conceptual framework is proposed to better understand the dynamics of HIV chronic comorbidities.

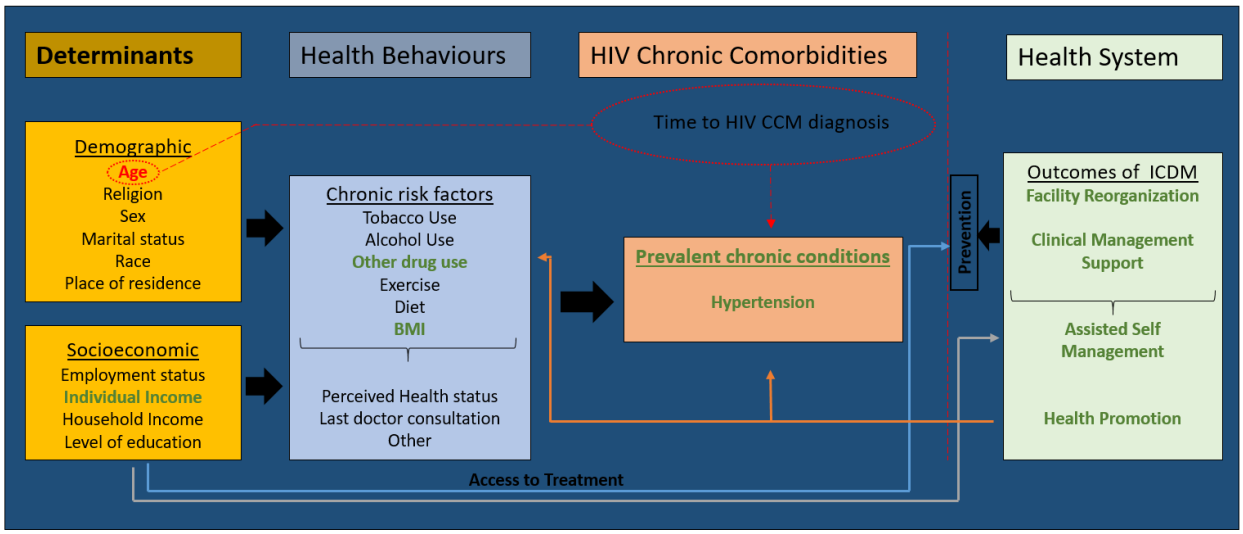

Figure 5.1: Revised conceptual framework for study on development and care for PLWH with the Comorbidity of hypertension

The revised conceptual framework shows the following amendments:

1. This framework draws specific attention to the development of hypertension among PLWH given that the study findings have confirmed the risk of hypertension to be heightened among PLWH.
2. Age is an important predictor variable for the development of chronic diseases in PLWH. The age variable can be used as a time variable to predict the development of hypertension among HIV positive adults as shown in this study. The new conceptual framework highlights the importance of age and shows its effect on time and the Comorbidity of HIV and hypertension.
3. This study found that inequality in socio-economic status can have an influence on access to treatment and the prevention and management of comorbidities. The pathway through which socio-economic variables affect the outcomes of the ICDM model have now been clearly shown.
4. At a health systems level, facilities play an important role in promoting positive health behaviours and ensuring that patients are informed about the preventing chronic risk factors that lead to the development of chronic comorbidities. Additionally, effective clinical management and ensuring that services are provided efficiently can assist patients to better manage HIV chronic comorbidities.

5. Lastly, other important predictor variables that are worth exploring in future studies have been added. These include individual income, other drug use, and BMI.

5.2.6. Contribution to Body of Knowledge

One of the main contributions of this study to existing body of knowledge is the assessment of the time (age) before PLWH develop hypertension. The HIV epidemic in South Africa is greater than any country, globally (AVERT, 2019a). Fortunately, the country has made significant progress towards the 90-90-90 targets. In 2020, 92% of HIV infected persons knew their status of which 75% were on treatment (AVERT, 2019a). About 7.5 million of these HIV infected persons, ART naïve or not, will be at risk of chronic disease in their lifespan (AVERT, 2019a; Chhoun et al., 2017; Rodríguez-Arbolí et al., 2017). This study has revealed an earlier risk (≥ 30) of HIV and hypertension Comorbidity. This is important because young adults infected with HIV can be included in HIV/NCD programmes and initiated early to assist them in preventing the development of chronic conditions such as hypertension. Currently, while the National Strategic Plan on the Prevention and Control of NCDs recognized that chronic conditions can affect younger people (SANAC, 2017), it does not include clear guidelines on the age groups that should be considered in chronic disease prevention efforts. This study is an important guide, even at a policy level.

The second contribution of this study is that it identified several barriers that may affect the ability of people living with HIV and other CCMs to prevent or manage these conditions were provided. At an individual level, the study has shown that socio-economic challenges such as unemployment, food insecurity, stigma, as well as polypharmacy may threaten HIV and chronic disease treatment adherence and the management of HIV comorbidities. The findings from the healthcare workers have enabled us to further assess the fidelity of the integrated chronic care disease model implemented in the South African health system, revealing that concentrated efforts should be made to strengthen clinical management support to make efficient the care and treatment for PLWH.

5.2.7. Study Strengths

A major strength of this study is the use of a mixed methods approach which provided a nuanced understanding of the dynamics of chronic disease development in PLWH. Other

studies have assessed chronic disease risk in PLWH either quantitatively or qualitatively. The quantitative studies have mostly done so using cross-sectional data. This study conducted analysis on longitudinal data which is another strength because causality could be inferred. On the other end, several qualitative studies have explored the experiences of patients with HIV CCMs, such as hypertension and diabetes. In this study, the challenges experienced by healthcare workers in providing treatment and care to persons living with HIV CCMs were also researched. In using both quantitative and qualitative methods, this study was able to better interpret the quantitative findings and as well as identify contradictions between the quantitative data and participant experiences.

The use of the Cox proportional hazard model of analysis is another strength of this study because other statistical models such as logistic regression cannot address issues of censoring which come up in longitudinal data. For example, while this study retrospectively followed HIV positive adults across 5 waves (2008-2017) to assess whether they developed an additional chronic condition, not all the study subjects would have developed hypertension with the timeframe of analysis. By applying Cox proportional procedures, both censored and uncensored observations were accounted for.

The fourth strength of this study is the effort made, alongside the adaptation of three different theoretical models, to propose a conceptual framework (figure 5.1) that can assist the reader and the HIV/NCD research community to move beyond thinking of HIV and chronic conditions in silos but understand the inter-related relationship between these diseases and to provide integrated treatment and care to patients affected by them.

5.2.8. Study Limitations and Mitigation Strategies

This study has important limitations. Firstly, information on ART was not available in the NIDS survey. This variable is important given the wide literature on the effect of ART on chronic disease development. To address this shortcoming, the qualitative component sampled HIV positive adults that were on ART and self-reported adherence for at least the past 12 months. Some studies have also cited the duration of HIV infection as a predictor for chronic disease development in PLWH. The lack of HIV infection variable is an important limitation in the survey. The duration of HIV infection among participants in this study could not be confirmed and may be a challenge to do so because the exact date whereby a person becomes infected is expected to be different from the date of testing positive. Rather, participants in the qualitative component of the research were asked to recall the year of HIV diagnosis. This was used to report on the duration that participants have HIV CCMs to provide insight on the time taken, in years, before PLWH develop chronic conditions such as hypertension and

diabetes. Another limitation of this study is that it relied on self-reported information on chronic disease risk factors such as smoking, alcohol use etc. in both the quantitative and qualitative research. Participants may have felt biased towards reporting good health seeking behaviours because of the nature of the study. Lastly, in the qualitative sub-study only participants from rural and peri-urban regions of South Africa were recruited. As a result, the possible differences with regards to the experiences of prevention and management of HIV CCMs from participants in urban areas were not investigated.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

This study sought to investigate three areas of interest: (1) The time before HIV positive adults develop a second chronic condition; (2) The factors associated with the development of a second chronic condition in PLWH and (3) The challenges regarding prevention, treatment and access to healthcare faced by adults with HIV chronic co-morbidities in South Africa.

Results from the Kaplan Meier survival analysis indicate that HIV infected persons are at risk of developing a second chronic condition, specifically hypertension, from the age of 30. While age is the time variable in this study, it is important to note that the time since HIV infection can have an effect on the development of hypertension. For example, while person x that contracts HIV between the age of 18 may be at high risk to develop hypertension after 15 years, person x who becomes diagnosed at birth with HIV may develop hypertension by the age of 15 years. However, the latter effects are not explored extensively in the current research because of limitations with the lack of the HIV infection variable in the survey dataset. The difference and effect of some demographic, socio-economic, and health characteristics on the development of hypertension in PLWH was also assessed. However, these factors were found insignificant in the Cox proportional regression but highlighted as important for prevention and management in the qualitative assessments. The development of chronic diseases in PLWH could be owed to several factors, including long term inflammation of the HI virus, effects of ART, or even family history of chronic disease infection as suggested by existing literature (Deeks, Lewin, et al., 2013; Yang et al., 2019a), which were not explored in this study. There was an insignificant relation found between hypertension Comorbidity and smoking tobacco or alcohol and a low prevalence of smoking or alcohol use reported in the qualitative fining. However, the effect of smoking and use of other drugs, such as marijuana, by PLWH should form part of future investigation because recent research has shown an increasing smoking prevalence among PLWH in South Africa (Elf et al., 2018).

As a summary of the findings in response to the final objective, the lack of information on chronic disease risk factors, long distance to health facility, unemployment, financial difficulties, stigma, and polypharmacy are some of the challenges affecting prevention, access to treatment and management of HIV CCMs at an individual level at least for participants in rural and peri-urban South Africa. Within the health system, limited staff, and lack of training on the delivery of the ICDM model are important barriers that negatively impact clinical support management.

Given the results from this research, health systems should include screening of HIV positive persons for other chronic conditions regularly and during ART consultations. Young adults diagnosed with HIV should begin to be prioritized for regular screening and prevention of NCDs. It paramount that the ICDM model that is implemented at the PHC level be strengthened to support persons living with HIV CCMs to prevent and manage these comorbidities.

6.2. Implications for Research and Policy

Overall, the research implication of this study is that it is the first to assess the time taken before hypertension development among PLWH using Cox proportional hazard models to retrospectively analyse longitudinal data. Other longitudinal studies on hypertension among PLWH have used logistic or Poisson regressions as their methods of analysis (Chang et al., 2019a; Seaberg et al., 2005; Sharman & Bachmann, 2019). This is except for one study by Rodríguez-Arbolí et al. (2017) that applied Cox proportional hazard model. However, this study only assessed the incidence, prevalence, and risk factors associated with hypertension development among PLWH (Rodríguez-Arbolí et al., 2017). The uniqueness of this research in the context of the existing body of research is, therefore, in the methods used to understand an important phenomenon that has not been widely researched. In including an in-depth understanding of the challenges faced by adults living with HIV CCMs, this study creates emphasis on the need for mixed methods approaches in HIV research.

The study findings in this paper have some important policy implications.

Firstly, it is now evident that PLWH are at risk of hypertension Comorbidity from an earlier age. Therefore, there is a need for HIV and Aids policies and policies such as the National Strategic Plan on the prevention on NCDs to scale up interventions to assist in the prevention of HIV CCM, targeting young people as well. Additionally, the morbidity and mortality associated with Comorbidity diagnosis can decrease the overall life expectancy of PLWH. To increase life expectancy and reduce the burden of communicable and non-communicable diseases already present in the health system, programmes such as the National ART programme, the Test and Treat programme, project HOPE and the Chronic Disease Rehabilitation programme (CDRP) which are presently working to address issues of HIV and chronic disease prevalence in the country need to be strengthened to address prevention and management of HIV CCMs.

This is important because hypertension is a risk factor for diabetes and other CVDs.

Secondly, this study revealed several other challenges that affect adults living with HIV CCMs to prevent, access treatment, and manage their comorbid conditions. It is important for the departments of Health and Social Development to work together in strengthening health systems through, for example, using lay counsellors and entry level nurses to provide regular home-based care for people who find it difficult to access the health facility or express other barriers to treatment access.

Thirdly, the early age of hypertension risk among PLWH implies that policies on education should ensure that lessons on chronic risk factors are incorporated into HIV education at schools, varsities and within clinic settings and other areas where the younger population is accessible easily. It is even more important to educate young people early to not think of HIV and chronic diseases in silos but to identify that these chronic conditions are closely related.

Finally, this study showed that the lack of adequate information on HIV CCM prevention and management leads to anxiety for the persons living with these conditions and healthcare providers alike. Information dissemination is important and can be done using various channels such as posters in clinics or hospitals or by relying on eHealth.

6.3. Recommendations

This study provided the following recommendations:

Technical recommendations

- The NIDS survey used in this study did not collect information on ART. Studies, including surveys, on HIV should include variables on ART use and adherence.
- Socio-economic status is an important predictor for access to treatment and as observed in this study, management of comorbidities. Other proxies for measuring socio-economic status such individual income, access to resources and household assets should be used in assessing for the impact of socio-economic status on health outcomes.
- The limitation in self-reported data makes it important for health data to be verified. To understand chronic risk factors such as smoking or alcohol use, studies should conduct carbon monoxide tests and report on HIV test outcomes as opposed to self-reported information.

Policy recommendations

- HIV positive individuals should be routinely tested for other chronic diseases, particularly hypertension give the close correlation between the two conditions. Tested can be conducted upon collection of ART or through home-based care.
- Socio-economic empowerment should form part of HIV and chronic disease programmes and policies as the lack of affects prevention, access to treatment and management of comorbidities. Empowerment can take the form of investing in targeted skills development for PLWH, unemployment grants, and offering food parcels through the Department of Social Development to eliminate issues of food security and financial difficulties in managing comorbid conditions.
- The health system can consider transferring treatment and care of HIV CCMs to the home by leveraging off the pilot home link study in South Africa that is using lay counsellors and enrolled (entry level) nurses to bring clinical care and counselling to the homes of patients living with HIV.

6.4. Frontiers for Further Research

The present study has assessed the time taken for PLWH to develop hypertension and the factors associated with the development of HIV CCMs both quantitatively and qualitatively. Additionally, it has examined the fidelity of the health system qualitatively to provide insight on care needed for persons living with HIV CCMs. However, further research is required to better understand the dynamics of chronic disease development in PLWH. Future studies can look at some of the following areas:

- The factors associated with the early onset of hypertension among PLWH need to be explored further.
- There is a need to assess loss to follow up of patients with HIV chronic conditions, including adherence to HIV and chronic medication.
- Lack of information on chronic disease prevention was found to be an important barrier to prevention and management of HIV CCMs. Research on the use of eHealth tools in HIV and chronic disease education is essential. Use of longitudinal methods to follow up HIV positive adults retrospectively or prospectively over a longer period (>10 years) to determine the development of other chronic conditions; this includes assessing hypertension development across all waves of the NIDS survey and the changes in the prevalence of hypertension among PLWH overtime

- Understanding social context and its effect on the prevention and management of HIV CCM
- Identify and assessing the impact of HIV infection on chronic disease development
- Compare the risk of hypertension and other chronic conditions in HIV positive and HIV negative adults; distinguishing by age and years lived
- Finally, future studies should perform analysis on larger longitudinal dataset with a bigger sample size to allow for effects of each of the independent variables of hypertension/chronic disease development among PLWH to be assessed extensively

The conclusion of this thesis is that hypertension is a prevalent chronic condition among adults living with HIV and young adults are equally at risk of hypertension as older adults living with HIV. Given the high HIV pandemic among young people in South Africa, priority should be given to ways that this young population can be prevented from developing additional chronic conditions. Additionally, to mitigate the burden placed on health systems caused by the HIV and NCDs, chronic disease prevention and education should be integrated into HIV routine care and these services should be extended to all persons living with HIV irrespective of age. One of the important ways to achieve this is through strengthening the ICDM and ensuring that all health facilities at the primary healthcare level adopt the model.

The management of HIV CCMs is difficult for patients and is challenged by an array of demographic and socio-economic factors that can be addressed through macro policy reforms such as increasing employment opportunities and access to health facilities. Even so, a feasible solution to assist patients could be to establish and provide support programmes that cater not only for people living with HIV but those diagnosed with comorbidities as well. Important concluding points are as follows:

1. HIV infected persons need to routinely screen for chronic diseases, especially hypertension during ART consultation.
2. The integrated HIV and chronic disease prevention and management service should be extended to youth given the new evidence that the risk of hypertension is increased from an early age.
3. Religious organisations should be engaged in HIV and chronic prevention initiates as they are a trusted source of information.
4. Finally, the ICDM model in South Africa needs to be re-evaluated and strengthened by increasing training initiatives, ensuring that the training and guidelines are standardized and investing in health and promotion.

A take home message is that the effective integration of HIV and chronic disease services is critical in addressing the growing burden of HIV and hypertension Comorbidity among young and old populations

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APPENDIX A: Additional Quantitative Results

Wave 1: Levels of HIV positive adults aged 18 – 75 year's old

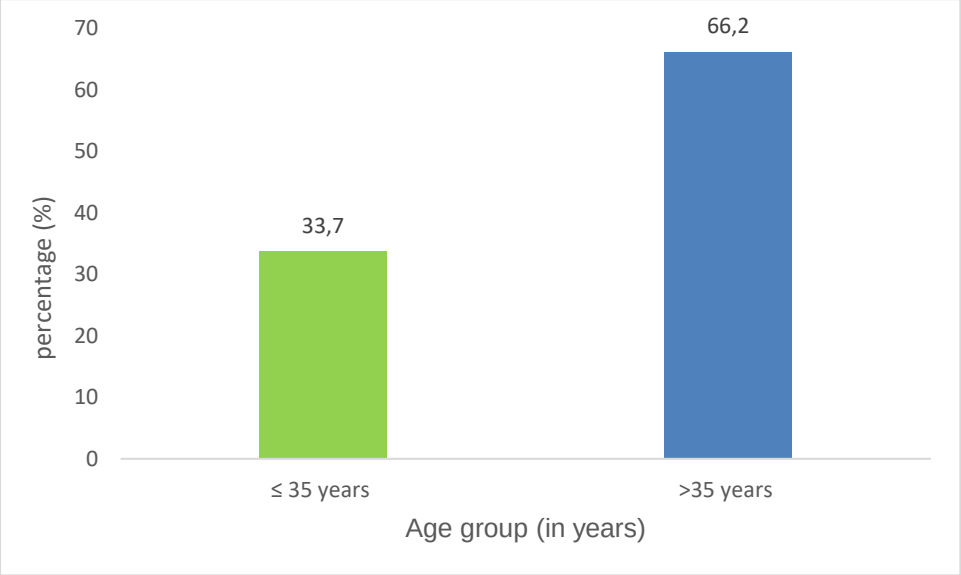

Figure A1: Levels of HIV positive adults aged 18 – 75 year's old

Wave 1: Characteristics of HIV positive adults living with diabetes

Table A1: Weighted frequencies and percentages of demographic characteristics of HIV positive adults diagnosed with diabetes at wave 1

	Diabetes Comorbidity		
Demographic Variables	**Diagnosed N=1 615**	**Undiagnosed 94 085**	**Total**

			95 701
Age			
≤ 35 years **(%)**	858.8 **(53.2)**	31 438.9 **(33.4)**	32 269.3 **(33.7)**
>35 years **(%)**	756.8 **(46.84)**	62 647.0 **(66.6)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	858.8 **(53.2)**	70 049.6 **(74.4)**	70 908.4 **(74.0)**
Male **(%)**	756.8 **(46.8)**	24 036.2 **(25.5)**	24 793.1 **(25.9)**
Marital status			
Never married **(%)**	1 615.6 **(100.0)**	57 735.1 **(61.4)**	59 350.7 **(62.0)**
Married **(%)**	0 **(0.0)**	36 350.7 **(38.6)**	36 350.7 **(37.9)**
Religion			
Other religion **(%)**	0 **(0.0)**	5 610.4 **(6.0)**	5 610.4 **(5.8)**
Christian **(%)**	1 615.6 **(100.0)**	88 475.4 **(94.0)**	90 091.0 **(94.1)**
Race			
Other (%)	0 **(0.0)**	1 609.9 **(1.7)**	1 609.9 **(1.6)**
African (%)	1 615.6 **(100.0)**	92 475.9 **(98.3)**	94 091.6 **(98.3)**
Place of residence			
Rural **(%)**	1 615.6 **(100.0)**	54 947.9 **(58.4)**	56 563.6 **(59.1)**
Urban **(%)**	0 **(0.0)**	39 137.9 **(41.6)**	39 137.9 **(40.8)**

In Table A1 above, ff the 1 615 HIV positive adults diagnosed with diabetes at wave 1, the majority were aged below 35 years old (53.1%), female (53.1%), all had never been married and were Christian (100%), predominately black Africans (100%) and all were residing in rural areas of South Africa (100%).

Table A2: Weighted frequencies and percentages of socio-economic characteristics of HIV positive adults diagnosed with diabetes at wave 1

	Diabetes Comorbidity		
Socio-economic Variables	**Diagnosed N=1 615**	**Undiagnosed N=94 085**	**Total N=95 701**
Employment status			
Unemployed **(%)**	1 615.6 (**100.0**)	85 818.0 **(91.2)**	87 433.6 **(91.3)**
Employed **(%)**	0 **(0.0)**	8 267.8 **(8.8)**	8 267.8 **(8.6)**
Household income			
B/low average **(%)**	1 615.6 **(100.0)**	71 926.0 **(80.0)**	73 541.7 **(81.0)**
Average **(%)**	0 **(0.0)**	17 196.3 **(20.0)**	17 196.3 **(18.9)**
Education level			
No education **(%)**	0 **(0.0)**	21 368.0 **(22.7)**	21 368.0 **(22.3)**
Some education **(%)**	1 615.6 **(100.0)**	72 717.8 **(77.3)**	74 333.5 **(77.6)**

From the 1 615 of adults living with the Comorbidity of HIV and Diabetes at wave 1, all were unemployed, with a below average household income but had all received some education (100%) (Table A2) .

Table A3: Weighted frequencies and percentages of health characteristics of HIV positive adults diagnosed with diabetes at wave 1

	Diabetes Comorbidity		
Health behaviour Variables	**Diagnosed N= 1 615**	**Undiagnosed N= 94 085**	**Total N= 95 701**
Tobacco use			
No **(%)**	1,615.6 **(100.0)**	74 207.3 **(78.9)**	75 822.9 **(79.2)**
Yes **(%)**	0 **(0.0)**	19 878.5 **(21.1)**	19 878.5 **(20.7)**
Alcohol use			
Do not drink **(%)**	1,615.6 **(100.0)**	71 594.1 **(76.1)**	73 209. **(76.5)**
Few times a month **(%)**	0 **(0.0)**	22 491.7 **(23.9)**	22 491.7 **(23.4)**
Exercise			
Never **(%)**	858.8 **(53.2)**	82 750.2 **(88.0)**	83 609.0 **(87.3)**
Once a week **(%)**	756.8 **(46.8)**	11 335.6 **(12.0)**	12 092.4 **(12.6)**
Perceived Health			
Poor **(%)**	1 615.6 **(100.0)**	74 489.4 **(79.2)**	76 105.0 **(79.5)**
Good **(%)**	0 **(0.0)**	19 596.4 **(20.8)**	19 596.4 **(20.4)**
Last Dr consultation			
Last 30 days **(%)**	1 615.6 **(100.0)**	63 853.4 **(67.9)**	65 469.1 **(68.4)**
1month + ago **(%)**	0 **(0.0)**	30 232.4 **(32.1)**	30 232.4 **(31.5)**

In terms of health behaviours, none (0%) of the HIV positive adults with diabetes Comorbidity reported to use tobacco and all 1 615 reported that they did not drink alcohol. About 46.8% said they exercised at least once a week while all 1 615 reported to have poor health. In addition, all the HIV positive adults with diabetes Comorbidity said that they had visited a doctor in the last 30 days (100%) (Table A3).

Wave 1: Characteristics of HIV positive adults living with heart problems

Table A4: Weighted frequencies and percentages of demographic characteristics of HIV and Comorbidityheart problem Comorbidity at wave 1

	Cardiovascular Disease Comorbidity		
Demographic Variables	**Diagnosed N=3 171**	**Undiagnosed N= 92 529**	**Total 95 701**
Age			
≤ 35 years **(%)**	0 **(0.0)**	32 297.7 **(34.9)**	32 297.1 **(33.7)**
>35 years **(%)**	3 171.5 **(100.0)**	60 232.2 **(65.1)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	2 011.0 **(63.4)**	68 897.4 **(74.5)**	70 908.4 **(74.0)**
Male **(%)**	1 160.5 **(36.6)**	23 632.5 (**25.5)**	24 793.1 **(25.9)**
Marital status			
Never married **(%)**	0 **(0.0)**	59 350.7 **(64.1)**	59 350.7 **(62.0)**
Married **(%)**	3 171.5 **(100.0)**	33 179.1 **(35.9)**	36 350.7 **(37.9)**
Religion			
Other religion **(%)**	0 **(0.0)**	5 610.4 **(6.1)**	5 610.4 **(5.8)**

Christian **(%)**	3 171.5 **(100.0)**	86 919.4 **(93.9)**	90 091.0 **(94.1)**
Race			
Other (%)	0 **(0.0)**	1 609.9 **(1.7)**	1 609.9 **(1.6)**
African (%)	3 171.5 **(100.0)**	90 920.0 **(98.3)**	94 091.6 **(98.3)**
Place of residence			
Rural **(%)**	2 011.0 **(63.4)**	54 552.6 **(59.0)**	56 563.6 **(59.1)**
Urban **(%)**	1 160.5 **(36.6)**	37 977.3 **(41.0)**	39 137.9 **(40.9)**

Of the 3171 adults with HIV and CVD Comorbidity at wave 1, all were aged above 35 years old. Most were female (63.4%), all were married (100%), Christian (100), predominately black Africans (100%) and the majority were residing in rural areas of South Africa (63.4%) (Table A4).

Table A5: Weighted frequencies and percentages of socio-economic characteristics of HIV and heart problem Comorbidity at wave 1

	Cardiovascular Disease Comorbidity		
Socio-economic Variables	**Diagnosed N= 3 171**	**Undiagnosed N= 92 529**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	3 171.5 **(100.0)**	84 262.0 **(91.1)**	87 433.6 **(91.3)**
Employed **(%)**	0 **(0.0)**	8 267.8 **(8.9)**	8 267.8 **(8.6)**
Household income			
B/low average **(%)**	2 011.0 **(63.4)**	71 530.6 **(81.7)**	73 541.7 **(81.0)**
Average (**%)**	1 160.5 **(36.6)**	16 035.8 **(18.3)**	17 196.3 **(18.9)**
Education level			
No education **(%)**	0 **(0.0)**	21 368.0 **(23.1)**	21 368.0 **(22.3)**
Some education **(%)**	3 171.5 **(100.0)**	71 161.9 **(76.9)**	74 333.5 **(77.6)**

**Some variables do not equal the total sample size because of missing variables = household income*

Of the HIV positive adults that were diagnosed with CVD at wave 1, all were unemployed (100%), the majority had a below average household income (63.4%) and all had received some form of education (100%) (Table A5).

Table A6: Weighted frequencies and percentages of health characteristics of HIV and heart problem Comorbidity at wave 1

	Cardiovascular Comorbidity		
Health behaviour Variables	**Diagnosed N= 3 171**	**Undiagnosed N= 92 529**	**Total N=95 701**
Tobacco use			
No **(%)**	2 011.0 **(63.4)**	73 811.9 **(79.8)**	75 822.9 **(79.2)**
Yes **(%)**	1 160.5 **(36.6)**	18 718.0 **(20.2)**	19 878.5 **(20.7)**
Alcohol use			
Do not drink **(%)**	3 171.5 **(100.0)**	70 038.2 **(75.7)**	73 209.8 **(76.5)**
Few times a month **(%)**	0 **(0.0)**	22 491.7 **(24.3)**	22 491.7 **(23.4)**

Exercise			
Never **(%)**	3 171.5 **(100.0)**	80 437.5 **(86.9)**	83 609.0 **(87.3)**
Once a week **(%)**	0 **(0.0)**	12 092.4 **(13.1)**	12 092.4 **(12.6)**
Perceived Health			
Poor **(%)**	2 011.0 **(63.4)**	74 094.0 **(80.1)**	76 105.0 **(79.5)**
Good **(%)**	1 160.5 **(36.6)**	18 435.9 **(19.9)**	19 596.4 **(20.4)**
Last Dr consultation			
Last 30 days **(%)**	2 011.0 **(63.4)**	63 458.0 **(68.6)**	65 469.1 **(68.4)**
1month + ago **(%)**	1 160.5 **(36.6)**	29 071.8 **(31.4)**	30 232.4 **(31.5)**

In terms of health behaviours, only about 36.5% of adults with HIV and CVD Comorbidity were smokers while all reported that they did not drink alcohol (100%). All these adults did not exercise (100%); about 63.4% said they had poor health and at least 36.5% said their last doctor's visit was more than one month ago (Table A6) .

Wave 2: Levels of HIV CCMs at wave 2

The table below summarises the levels of hypertension, diabetes and cardiovascular disease among adults living with HIV at wave two of the NIDS survey.

Table A7: Levels of Chronic Conditions at wave 2

HIV Comorbidity Type	Weighted Frequency (N)	Percentage (%)
Hypertension		
Diagnosed	**8 247.50**	**8.6**
Undiagnosed	87 454.06	91.4
Diabetes		
Diagnosed	**28.40**	**0.0**
Undiagnosed	95 673.16	100.0
Heart probelm		
Diagnosed	**3 236.38**	**3.4**
Undiagnosed	92 465.18	96.6
Total	**95,701.56**	**100**

According to Table A7, At wave one, 10 131 HIV positive adults were living with hypertension. Between 2008 and 2011, this number reduced to 8 247, representing about 8.6% of the HIV positive population in this study. Evidently, about 1 884 HIV positive adults that were additionally diagnosed with hypertension were loss to follow up. In terms of diabetes Comorbidity, while 1.69% (n=1 165) of the HIV positive sample in wave 1 was living with hypertension, at wave 2, only 28.40 (0.03%) presented with diabetes Comorbidity. The attrition for diabetes at wave 2 is n=1 587. Lastly, about 3.31% of the study sample was living with the Comorbidity of hypertension and cardiovascular disease. At wave 2, this percentage increased to 3.4%, indicating an increase of 0.1% of new CVD diagnosis.

Wave 2: Characteristics of HIV positive sample

Percentage and frequency distribution of the demographic, socio-economic and health characteristics of the adults diagnosed with HIV and either hypertension, diabetes, or cardiovascular disease at wave 2 of the NIDS Survey are presented. This is done to account for any changes in the characteristics between the first and second wave.

Table A8: Weighted frequencies and percentages of the demographic characteristics of HIV positive adults diagnosed with hypertension at wave 2

	Hypertension Comorbidity		
Demographic Variables	**Diagnosed N=8 247**	**Undiagnosed N= 87 454**	**Total N= 95701**
Age			
≤ 35 years **(%)**	575.6 **(7.0)**	31,722.1 **(36.3)**	32,297.7 **(33.8)**
>35 years **(%)**	7,671.8 **(93.0)**	55,731.9 **(63.7)**	63,403.8 **(66.2)**
Gender			
Female **(%)**	8,247.5 **(100.0)**	40,922.1 **(46.8)**	49 169.6 **(51.3)**
Male **(%)**	0 **(0.0)**	46,531.9 **(53.2)**	46 531.9 **(48.6)**
Marital status			
Never married **(%)**	1,198.4 **(14.5)**	69,201.5 **(79.1)**	70 399.9 **(73.5)**
Married **(%)**	7,049.0 **(85.5)**	18,252.5 **(20.9)**	25 301.6 **(26.4)**
Religion			
Other religion **(%)**	0 **(0.0)**	24,280.9 **(27.8)**	24 280.9 **(25.3)**
Christian **(%)**	8,247.5 **(100.0)**	63,173.1 **(72.2)**	71 420.6 **(74.6)**
Race			
Other (%)	1,198.4 **(14.5)**	496.2 **(0.6)**	1 694.6 **(1.7)**
African (%)	7,049.0 **(85.5)**	86,957.8 **(99.4)**	94 006.9 **(98.2)**
Place of residence			
Rural **(%)**	547.2 **(6.6)**	33,987.9 **(38.9)**	34 535.1 **(36.1)**
Urban **(%)**	7,700.2 **(93.4)**	53,466.1 **(61.1)**	61 166.4 **(63.9)**

Table A8 above shows that of the 8,247 HIV positive adults living with hypertension at wave two, a large proportion were older than 35 years of age (93%), all were female (100%) and the majority were married (85.4%). Of these adults, all were Christian (100%), predominately Black Africans (85.4%) and residing in urban areas of South Africa (93.3%).

Table A9: Weighted frequencies and percentages of the Socio-economic characteristics of HIV positive adults diagnosed with hypertension at wave 2

	Hypertension Comorbidity		
Socio-economic Variables	**Diagnosed N= 8 247**	**Undiagnosed N= 87 454**	**Total N=95 701**
Employment status			
Unemployed **(%)**	7,700.2 **(93.4)**	71,446.9 **(81.7)**	79 147.2 **(82.7)**

Employed **(%)**	547.2 **(6.6)**	16,007.1 **(18.3)**	16 554.3 **(17.2)**
Household income			
B/low average **(%)**	7,086.9 **(86.0)**	58,504.5 **(66.9)**	65 591.5 **(68.5)**
Average (**%)**	1,160.5 **(14.0)**	28,949.5 **(33.1)**	30 110.0 **(31.4)**
Education level			
No education **(%)**	0 **(0.0)**	8,146.0 **(9.3)**	8 146.0 **(8.5)**
Some education **(%)**	8,247.5 **(100.0)**	79,308.0 **(90.7)**	87 555.5 **(91.4)**

In terms of socio-economic status, the largest proportion of adults living with HIV and hypertension Comorbidity at wave 2 were unemployed (93.3%), with a below average household income (85.9%) and all had received some form of education (100%) (Table A9) .

Table A10: Weighted frequencies and percentages of the of Health behaviour characteristics of HIV positive adults diagnosed with hypertension at wave 2

	Hypertension Comorbidity		
Health behaviour Variables	**Diagnosed N= 8 247**	**Undiagnosed N= 87 454**	**Total N= 95 701**
Tobacco use			
No **(%)**	8,247.5 **(100.0)**	70,485.9 **(80.6)**	78 733.4 **(82.2)**
Yes **(%)**	0 **(0.0)**	16,968.0 **(19.4)**	16 968.0 **(17.7)**
Alcohol use			
Do not drink **(%)**	8,247.5 **(100.0)**	58,403.0 **(66.8)**	66 650.5 **(69.6)**
Few times a month **(%)**	0 **(0.0)**	29,051.0 **(33.2)**	29 051.0 **(30.3)**
Exercise			
Never **(%)**	7,086.9 **(85.9)**	71,602.5 **(81.9)**	78 689.4 **(82.2)**
Once a week **(%)**	1,160.5 **(14.1)**	15,851.5 **(18.1)**	17 102.0 **(17.8)**
Perceived Health			
Poor **(%)**	575.6 **(7.0)**	12,841.7 **(14.7)**	13 417.3 (**14.0)**
Good **(%)**	7,671.8 **(93.0)**	74,612.3 **(85.3)**	82 284.2 **(85.9)**
Last Dr consultation			
Last 30 days **(%)**	1,188.9 **(14.4)**	40,776.5 **(46.6)**	41 965.4 **(43.8)**
1 month + ago **(%)**	7,058.5 **(85.6)**	46,677.5 **(53.4)**	53 736.0 **(56.1)**

There were 8 247/95 701 HIV positive adults living with HIV and hypertension at wave 2. Of these all reported that they did not smoke, or drink alcohol (100%) and the majority said that they did not exercise (85.9%). In terms of perceived health, a large proportion (93%) reported to have good health and only about 14% had visited a doctor in the past 30 days (Table A10).

Table A11: Weighted frequencies and percentages of demographic characteristics of HIV positive adults diagnosed with diabetes at wave 2

	Diabetes Comorbidity		
Demographic Variables	**Diagnosed N= 28**	**Undiagnosed N= 95 673**	**Total N= 95 701**
Age			

≤ 35 years **(%)**	28.4 **(100.0)**	32,269.3 **(33.7)**	32 269.3 **(33.7)**
>35 years **(%)**	0 **(0.0)**	63,403.8 **(66.3)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	28.4 **(100.0)**	49,141.2 **(51.4)**	49,169.6 **(51.3)**
Male **(%)**	0 **(0.0)**	46,531.9 **(48.6)**	46,531.9 **(48.6)**
Marital status			
Never married **(%)**	0 **(0.0)**	70,399.9 **(73.6)**	70,399.9 **(73.5)**
Married **(%)**	28.4 **(100.0)**	25,273.2 **(26.4)**	25,301.6 **(26.4)**
Religion			
Other religion **(%)**	0 **(0.0)**	24,280.9 **(25.4)**	24,280.9 **(25.4)**
Christian **(%)**	28.4 **(100.0)**	71,392.2 **(74.6)**	71,420.6 **(74.6)**
Race			
Other (%)	0 **(0.0)**	1 694.6 **(1.8)**	1 694.6 **(1.7)**
African (%)	28.4 **(100.0)**	93 978.5 **(98.2)**	94 006.9**(98.2)**
Place of residence			
Rural **(%)**	0 **(0.0)**	34 535.1 **(36.1)**	34 535.1**(36.0)**
Urban **(%)**	28.4 **(100.0)**	61 138.0 **(63.9)**	61 166.4 **(63.9)**

Overall, 28 HIV positive adults were diagnosed with diabetes at wave 2. Of these, all were below the age of 35 years, female, married, predominately Black Africans and residing in urban areas of South Africa (100%) (Table A11).

Table A12: Weighted frequencies and percentages of socio-economic characteristics of HIV positive adults diagnosed with diabetes at wave 2

	Diabetes Comorbidity		
Socio-economic Variables	**Diagnosed N= 28**	**Undiagnosed N= 95 673**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	28.4 **(100.0)**	79 118.8 **(82.7)**	79 147.2 **(82.7)**
Employed **(%)**	0 **(0.0)**	16 554.3 **(17.3)**	16 554.3 **(17.3)**
Household income			
B/low average **(%)**	28.4 **(100.0)**	65 563.1 **(68.5)**	65 591.5 **(68.5)**
Average (**%)**	0 **(0.0)**	30 110.0 **(31.5)**	30 110.0 **(31.5)**
Education level			
No education **(%)**	0 **(0.0)**	8 146.0 **(8.5)**	8 146.0 **(5.5)**
Some education **(%)**	28.4 **(100.0)**	87 527.1 **(91.5)**	87 555. **(91.5)**

From the 28 of adults living with the Comorbidity of HIV and Diabetes at wave 2, all were unemployed, had a below average household income and had received some form of education (100%) (Table A12).

Table A13: Weighted frequencies and percentages of health characteristics of HIV positive adults diagnosed with diabetes at wave 2

	Diabetes Comorbidity		
Health behaviour Variables	**Diagnosed N= 28**	**Undiagnosed N= 95 673**	**Total N= 95 701**

Tobacco use			
No **(%)**	28.4 **(100.0)**	78 705.0 **(82.3)**	78 733.4 **(82.2)**
Yes **(%)**	0 **(0.0)**	19 878.5 **(17.7)**	16 968.0 **(17.7)**
Alcohol use			
Do not drink **(%)**	28.4 **(100.0)**	66,622.1 (**69.6)**	66,650.5 **(69.6)**
Few times a month **(%)**	0 **(0.0.0)**	29,051.01 **(30.4)**	29,051.0 (**30.4)**
Exercise			
Never **(%)**	28.4 **(100.0)**	78,661.0 **(82.2)**	78,689.4 **(82.2)**
Once a week **(%)**	0 **(0.0)**	17,012.0 **(17.8)**	17,012.0 **(17.8)**
Perceived Health			
Poor **(%)**	28.4 **(100.0)**	13,388.9 **(14.0)**	13,417.3 (**14.0)**
Good **(%)**	0 **(0.0)**	82,284.2 **(86.0)**	82,284.2 **(85.9)**
Last Dr consultation			
Last 30 days **(%)**	28.4 **(100.0)**	41,937.0 **(43.83)**	41,965.4 **(43.8)**
1month + ago **(%)**	0 **(0.0)**	53,736.0 **(56.17)**	53,736.0 **(56.1)**

In terms of health behaviours, again none (0%) of the HIV positive adults with diabetes Comorbidity reported to use tobacco and all 28 reported that they did not drink alcohol or exercise (100%). In addition, all 1 615 reported to have poor health and said that they had visited a doctor in the last 30 days (100%) (Table A13).

Table A14: Weighted frequencies and percentages of demographic characteristics of HIV and cardiovascular Comorbidity at wave 2

	Cardiovascular Disease Comorbidity		
Demographic Variables	**Diagnosed N=3 236**	**Undiagnosed N= 92 465**	**Total 95 701**
Age			
≤ 35 years **(%)**	3,236.3 **(100.0)**	29,061.3 **(31.4)**	32 297.1 **(33.7)**
>35 years **(%)**	0 **(0.0)**	60 232.2 **(68.6)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	3,236.3 **(100.0)**	45,933.2 **(49.7)**	49,169.6 **(51.3)**
Male **(%)**	0 **(0.0)**	46,531.9 (**50.3)**	46,531.9 **(48.6)**
Marital status			
Never married **(%)**	0 **(0.0)**	70,399.9 **(76.1)**	70,399.9 **(73.5)**
Married **(%)**	3,236.3 **(100.0)**	22,065.2 **(23.9)**	25,301.6 **(26.4)**
Religion			
Other religion **(%)**	0 **(0.0)**	24,280.9 **(26.3)**	24,280.9 **(25.3)**
Christian **(%)**	3,236.3 **(100.0)**	68,184.2 **(73.7)**	71,420.6 **(74.6)**
Race			
Other (%)	0 **(0.0)**	1,694.6 **(1.8)**	1,694.6 **(1.7)**
African (%)	3,236.3 **(100.0)**	90,770.5 **(98.2)**	94,006.9 **(98.2)**
Place of residence			
Rural **(%)**	0 **(100.0)**	34,535.1 **(37.3)**	34,535.1 **(36.0)**
Urban **(%)**	3,236.3 **(0.0)**	57,930.0 **(62.7)**	61,166.4 **(63.9)**

Of the 3 236 adults with HIV and cardiovascular disease Comorbidity at wave 2, all were aged below 35 years old (100%). All Most were female, married, Christian, predominately black Africans and the majority were residing in urban areas of South Africa (100%) (Table A14) .

Table A15: Weighted frequencies and percentages of socio-economic characteristics of HIV and cardiovascular Comorbidity at wave 2

	Cardiovascular Disease Comorbidity		
Socio-economic Variables	**Diagnosed N= 3 236**	**Undiagnosed N= 92 465**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	3,236.3 **(100.0)**	75,910.8 **(82.1)**	79,147.2 **(82.7)**
Employed **(%)**	0 **(0.0)**	16,554.3 **(17.9)**	16,554.3 **(17.3)**
Household income			
B/low average **(%)**	3,236.3 **(100.0)**	62,355.1 **(67.4)**	65,591.5 **(68.5)**
Average (**%)**	0 **(0.0)**	30,110.0 **(32.6)**	30,110.0 **(31.4)**
Education level			
No education **(%)**	0 **(0.0)**	8,146.0 **(8.8)**	8,146.0 **(8.5)**
Some education **(%)**	3,236.3 **(100.0)**	84,319.1 **(91.2)**	87,555.5 **(91.4)**

**Some variables do not equal the total sample size because of missing variables = household income*

Of the HIV positive adults that were diagnosed with cardiovascular disease at wave 2, all were unemployed, had a below average household income and all had received some form of education (100%) (Table A15).

Table A16: Weighted frequencies and percentages of health characteristics of HIV and cardiovascular Comorbidity at wave 2

	Cardiovascular Comorbidity		
Health behaviour Variables	**Diagnosed N= 3 236**	**Undiagnosed N= 92 465**	**Total N=95 701**
Tobacco use			
No **(%)**	3,236.3 **(100.0)**	75,497.0 **(81.6)**	78,733.4 **(82.2)**
Yes **(%)**	0 **(0.0)**	16,968.0 **(18.4)**	16,968.0 **(17.7)**
Alcohol use			
Do not drink **(%)**	3,236.3 **(100.0)**	63,414.1 **(68.6)**	66,650.5 **(69.6)**
Few times a month **(%)**	0 **(0.0)**	29,051.0 **(31.4)**	29,051.0 **(30.3)**
Exercise			
Never **(%)**	3,236.3 **(100.0)**	75,453.0 **(81.6)**	78,689.4 **(82.2)**
Once a week **(%)**	0 **(0.0)**	17,012.0 **(18.4)**	17,012.0 **(17.7)**
Perceived Health			
Poor **(%)**	28.4 **(0.9)**	13,388.9 (**14.5)**	13,417.3 **(14.0)**
Good **(%)**	3,207.9 **(99.1)**	79,076.2 **(85.5)**	82,284.2 **(85.9)**
Last Dr consultation			
Last 30 days **(%)**	3,236.3 **(100.0)**	38,729.0 **(41.9)**	41,965.4 **(43.8)**

1 month + ago **(%)**	0 **(0.0)**	53,736.0 **(58.1)**	53,736.0 **(56.1)**

Lastly with regards to health behaviours, all the adults with HIV and cardiovascular disease Comorbidity at wave 2 were not smokers and did not drink alcohol (100%). All reported that never exercise (100%) and the majority (99.1%) said they had good health. All said that they had visited a doctor in the past 30 days (Table A16).

Wave 3: Time to hypertension Comorbidity by other demographic, socio-economic and health characteristics

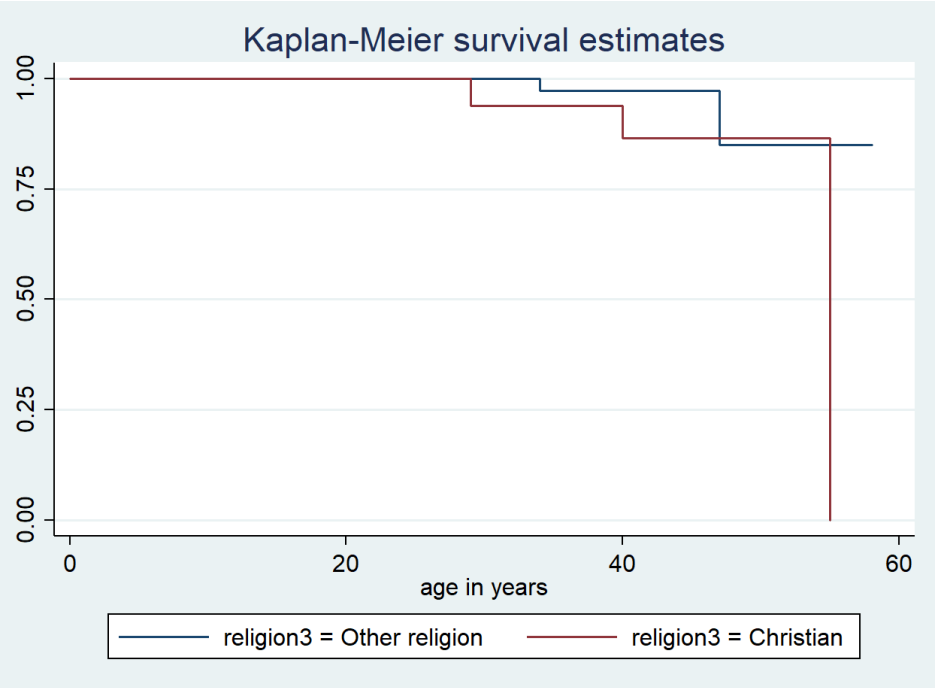

Figure A2: Hazard of hypertension Comorbidity by religion at wave 3

According to figure A2, the risk of hypertension Comorbidity begins at the age of 35 for HIV positive adults from other religious denominations and from the age of 30 for adults that are Christian. For Christians, the risk begins to decline from the age 30. Nonetheless, the risk of hypertension Comorbidity is highest for adults living with HIV from other religions as compared to Christians. About 90% of HIV positive adults from other religions aged 35 were at risk of developing hypertension Comorbidity. From the age of 35, the risk of hypertension Comorbidity begins to decline for this sample but remains high (about 80%) even at the age of 45.

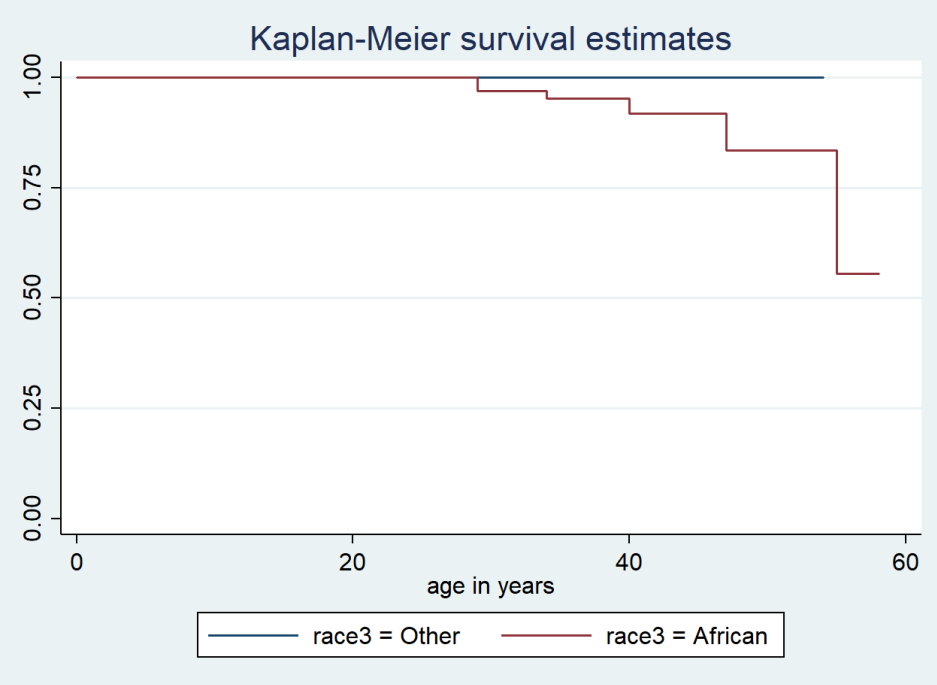

Figure A3: Hazard of hypertension Comorbidity by race at wave 3

In terms of race, the hazard of hypertension Comorbidity is highest for black African adults diagnosed with HIV as compared to adults from other races. The hazard for the Black African race group begins at the age of 30; with over 75% of adults aged between 30 – 40 being at risk of developing hypertension Comorbidity. From the age of 40, the hazard begins to decline with an increase in age. Interestingly, the HIV positive adults from other races in this study were not at risk of hypertension Comorbidity at least from age 0 – 50. This is indicated by the survival curve that shows that the endpoint of interest (hypertension Comorbidity) did not occur for HIV positive adults that were not black African (figure A3).

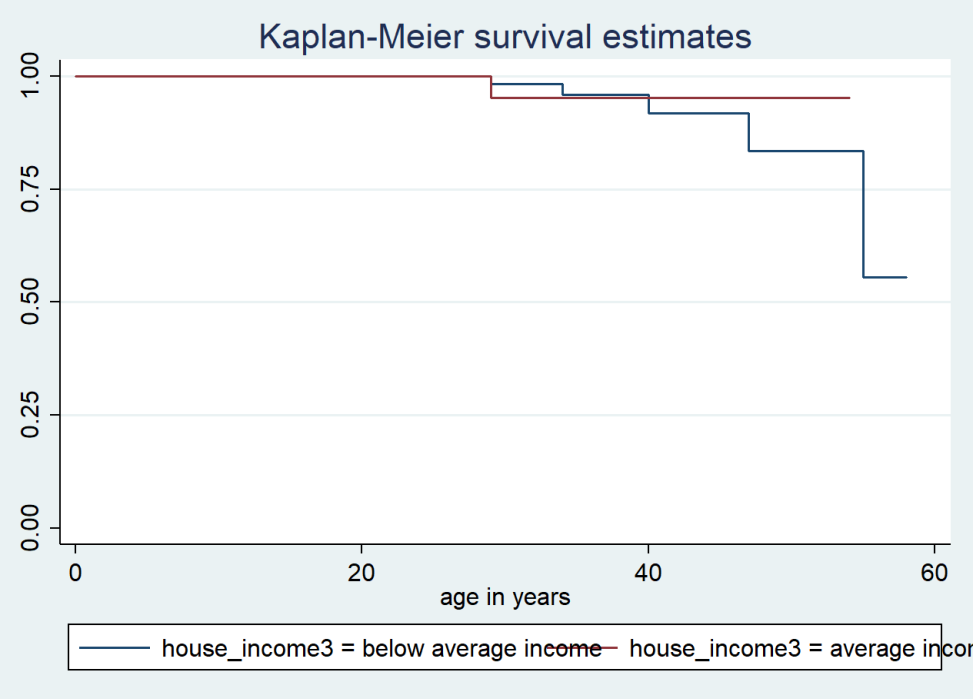

Figure A4: Hazard of hypertension Comorbidity by household income at wave 3

According to figure A4, hypertension Comorbidity is highest for HIV positive adults with a below average household income as compared to those who had an average household income. Over 80% of adults aged between 30 – 45 and from households with a below average household income were at risk of hypertension Comorbidity. For these adults, the risk of hypertension Comorbidity only begins to decline from the age of 45; with only about 55% being at risk of hypertension Comorbidity at the age of 55. For adults with an average household income, the hazard is highest at the age of 30 but thereafter declines from the age of 30 with an increase in age.

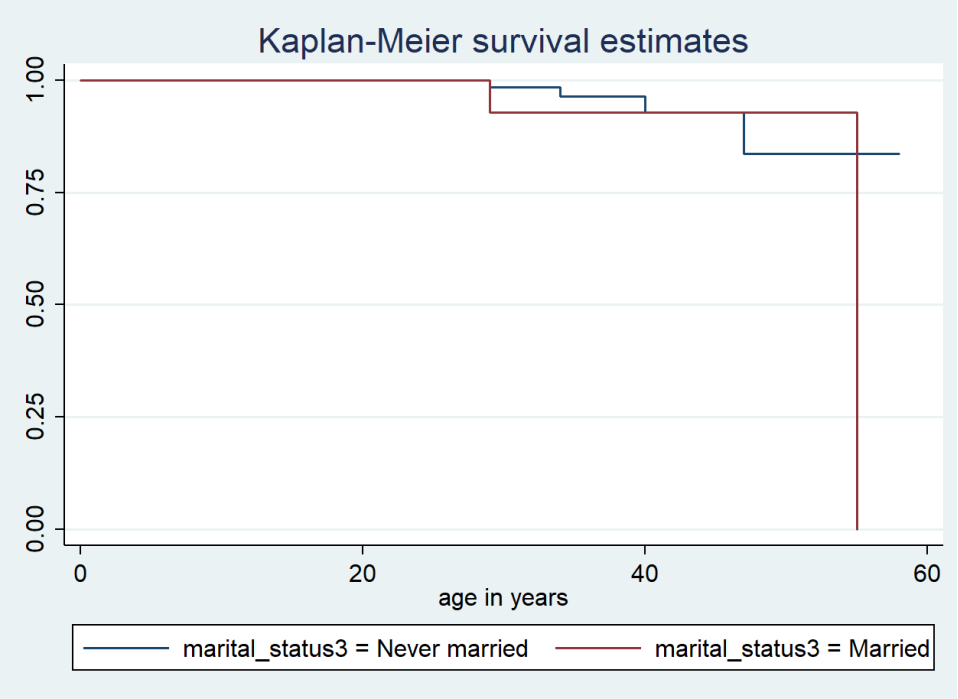

Figure A5: Hazard of hypertension Comorbidity by marital status at wave 3

With regards to marital status, the hazard for hypertension Comorbidity for adults living with HIV begins from the age of 30 for both adults that have never been married and those that are married. After the age of 30, the hazard declines for married adults. However, the hazard for hypertension Comorbidity is highest for HIV positive adults that have never been married as compared to those that have been married; with hazard being highest between the age of 30 – 40 years old. Over 95% of adults that have never been married and within this age group were at risk of developing hypertension Comorbidity. After the age of 40, the hazard begins to decline for never married adults but remains high even at the age of 45 at about 80% (figure A5).

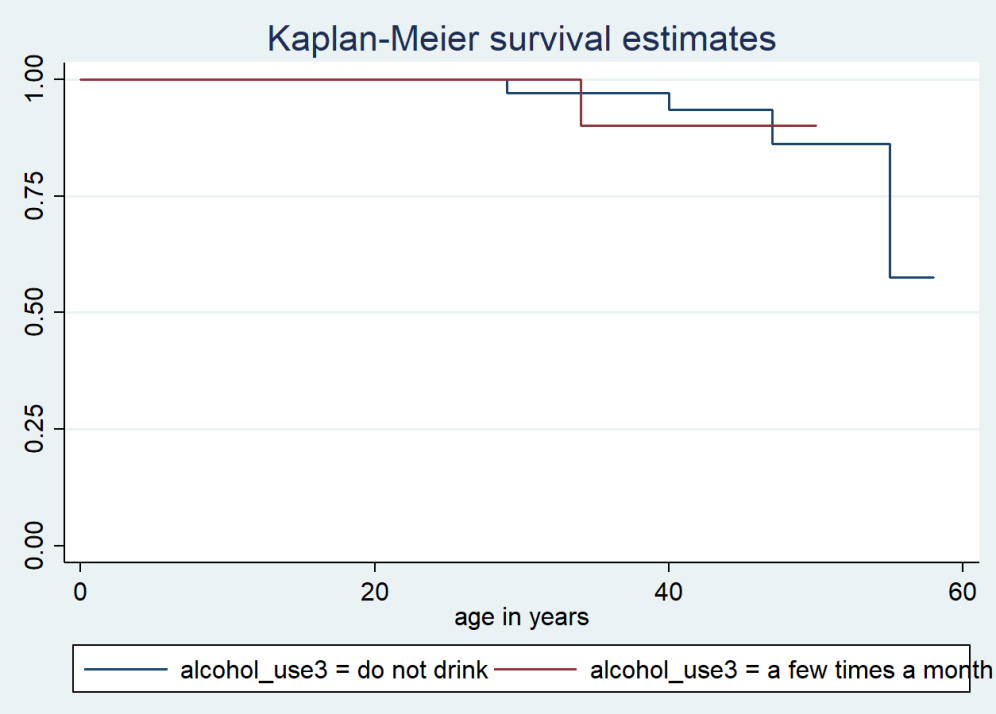

Figure A6: Hazard of hypertension Comorbidity by alcohol use at wave 3

Surprisingly as depicted in figure A6, hypertension Comorbidity is highest for adults living with HIV that do not drink alcohol as compared to that that reported to drink alcohol at least once a week. For adults that do not drink alcohol, the hazard of hypertension Comorbidity is highest between the age of 30; with about 90% of this sample having developed hypertension. The hazard begins to decline from the age of 30 but the hazard remained high (over 80%) even between the ages of 40 – 55. Among HIV positive adults that drink alcohol at least once a week, the hazard begins only at the age of 35 and thereafter decreases with an increase in age (figure A6) .

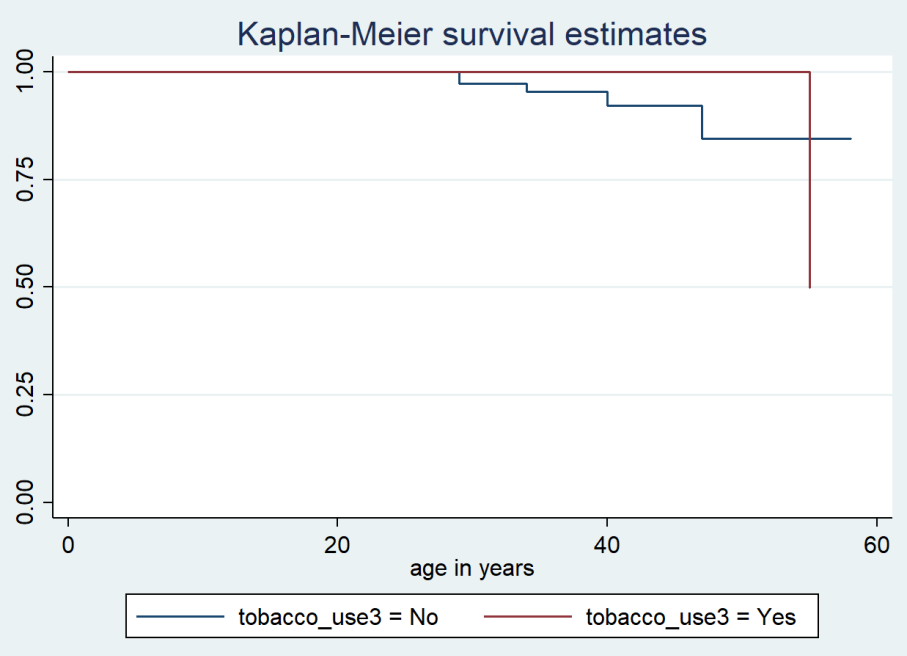

Figure A7: Hazard of hypertension Comorbidity by tobacco use at wave 3

Additionally, surprising, is the survival curve in figure A7 showing that hypertension Comorbidity is highest for adults living with HIV that did not smoke tobacco as compared to those that smoke. The hazard for adults that do not smoke is highest between the age of 30 – 45. Over 80% of adults living with HIV within this age group were at risk of hypertension Comorbidity. Thereafter, the hazard of hypertension begins to decrease with an increase in age.

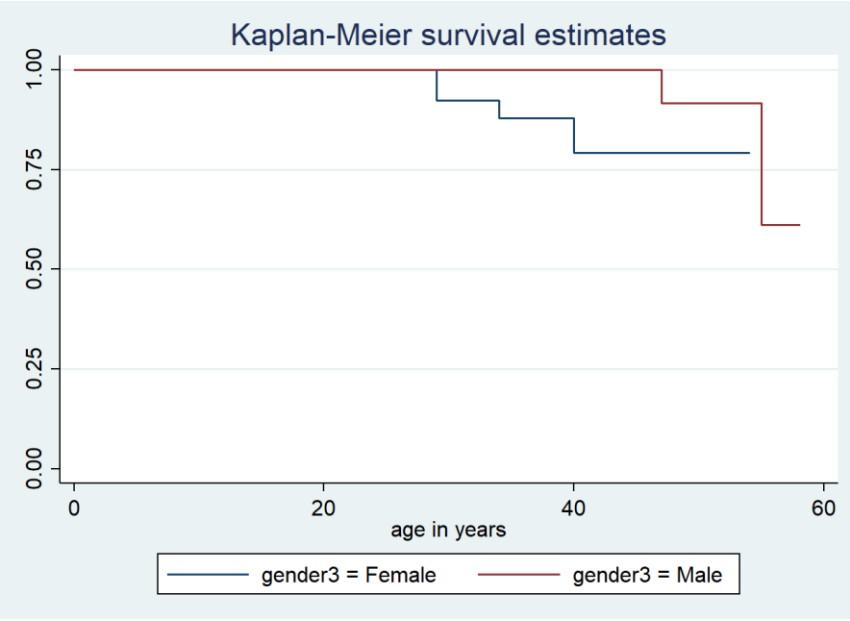

Figure A8: Hazard of hypertension Comorbidity by gender at wave 3

Figure A8 shows that hypertension Comorbidity is highest among females as compared to males, with the risk being highest between the ages of 30 – 40 years old. Over 75% of HIV

positive females in this age group were at risk of hypertension Comorbidity. Identifiably, this survival curve depicts those females living with HIV develop hypertension much earlier than males; with risk decreasing with an increase in age only after the age of 40. The risk of hypertension Comorbidity for males living with HIV begins from the age of about 45 and begins to decline from the age of 50 with an increase in age.

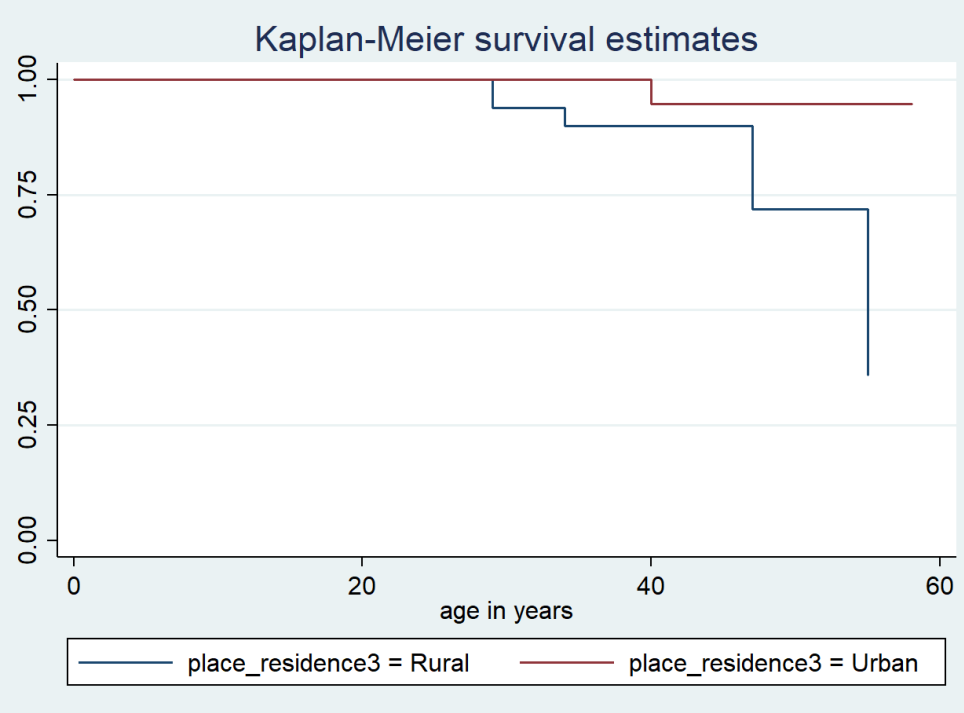

Figure A9: Hazard of hypertension Comorbidity by place of residence at wave 3

Figure A9 above depicts that hypertension Comorbidity is highest among HIV positive adults living in rural areas as compared to those that reside in urban areas; with hazard being the highest between age 30 and 35. The figure shows that hypertension Comorbidity occurs much earlier for HIV positive adults residing in rural areas. Over 80% of HIV positive adults aged 30 – 35 and residing in rural areas were at risk of hypertension Comorbidity. The hazard begins to decline from the age of 35 but only drops to just below 75% at the age of 45. For adults residing in urban areas, the hazard only occurs from the age of 40 and thereafter declines with an increase in age.

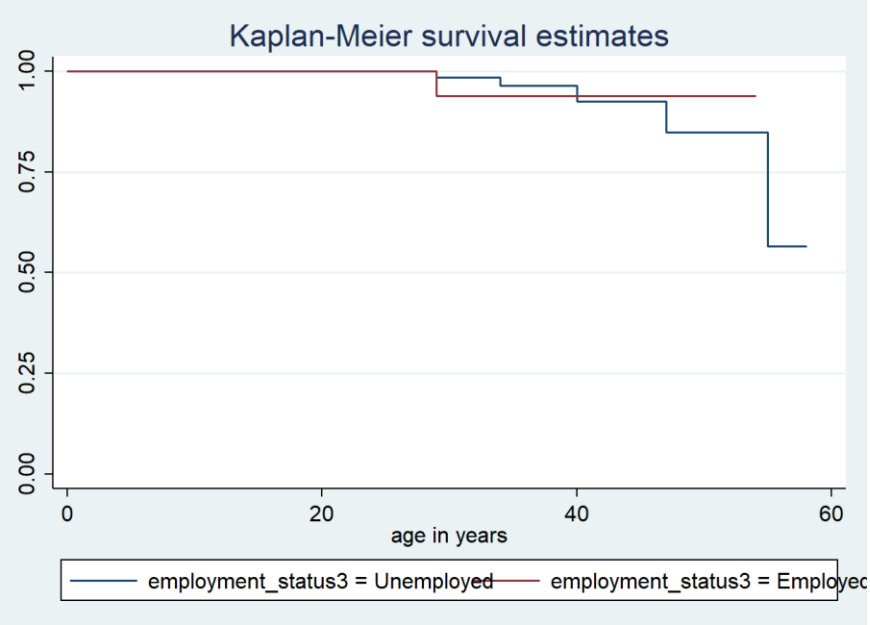

Figure A10: Hazard of hypertension Comorbidity by employment status at wave 3

With regarding to employment status, the survival curve shows that the hazard of hypertension Comorbidity is highest for HIV positive adults that are unemployed as compared to those that are employed, with the hazard being highest between age 30 – 45. Over 80% of HIV positive adults that were unemployed and in this age group were at risk of developing hypertension Comorbidity. From the age of 45, the hazard begins to decline and only after the age of 55 does the hazard drop to about 55%. For adults that are employed, the hazard occurs at the age of 30 but thereafter significantly declines (figure A10).

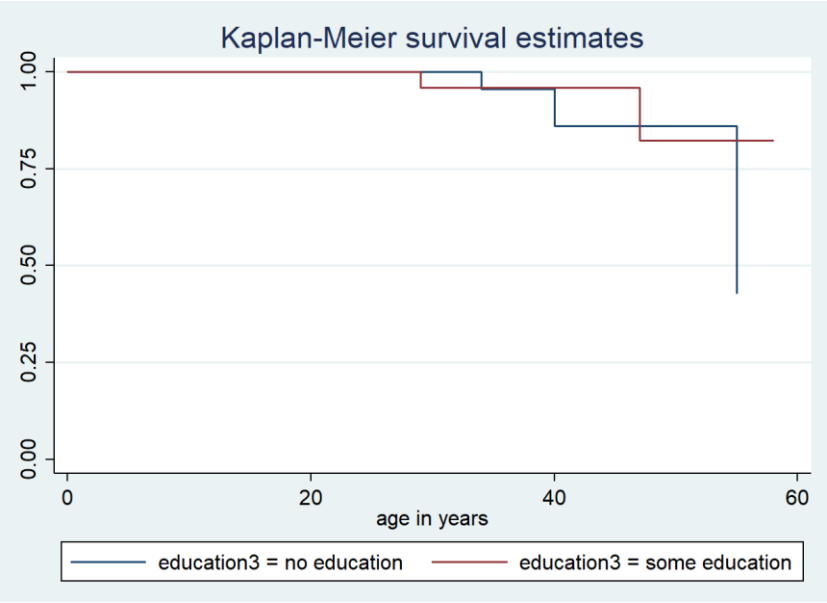

Figure A11: Hazard of hypertension Comorbidity by level of education at wave 3

Concerning level of education, the risk of hypertension Comorbidity is highest for HIV positive adults with no education as compared to those that have received some education; with risk

being highest between age 35 and 40. Over 80% of adults with no education and aged within this age group were at risk of hypertension Comorbidity. From the age of 40, the risk for hypertension Comorbidity begins to decline. The survival curve shows that the risk of hypertension Comorbidity occurs much earlier for adults that have received some education as compared to those with no education; with risk beginning from the age of 30. However, from the age of 30, the risk declines for this sample with an increase in age (figure A11).

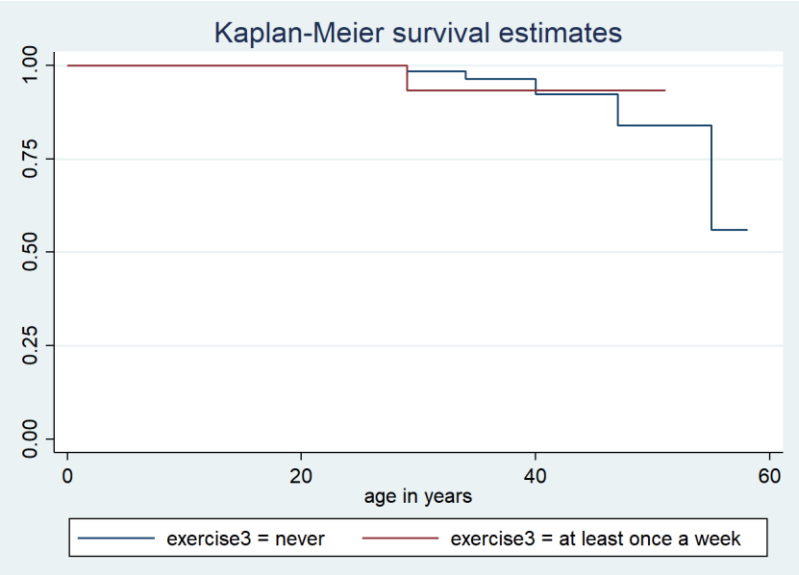

Figure A12: Hazard of hypertension Comorbidity by frequency of exercise at wave 3

According to figure A12, the hazard of hypertension Comorbidity is highest for HIV positive adults that never exercise as opposed to those that exercise at least once a week; with hazard being highest between the age of 30 – 40. Again, over 80% of HIV positive adults that do not exercise were at risk of hypertension Comorbidity between this age group. From the age of 40, the hazard of hypertension Comorbidity begins to decline with an increase in age for this sample. With regards to adults that exercise at least once a week, the hazard for hypertension Comorbidity occurred at age 30. Thereafter, the hazard decreases with an increase in age.

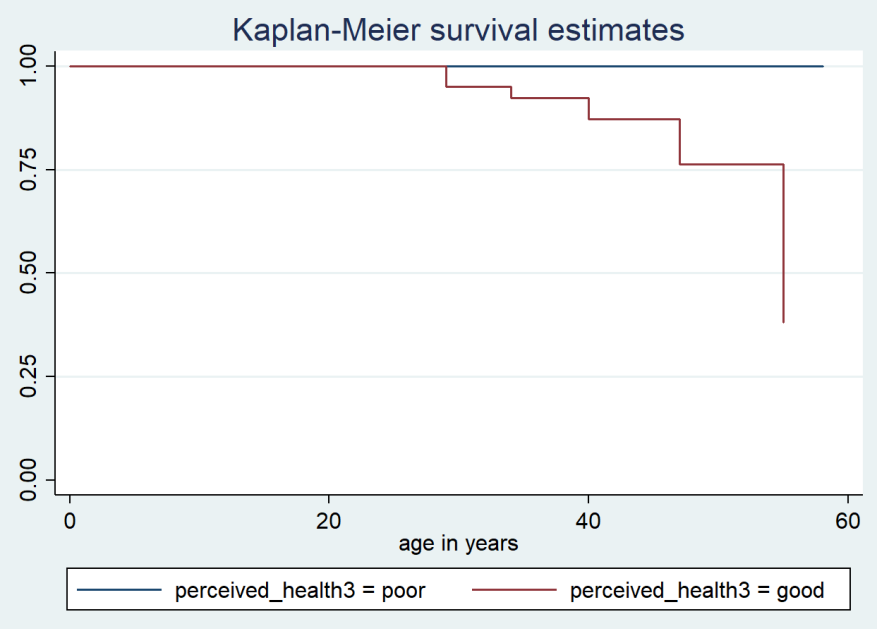

Figure A13: Hazard of hypertension Comorbidity by perceived health status at wave 3

In terms of perceived health status, the hazard of hypertension Comorbidity is highest for HIV positive adults that reported to have good health as compared to adults who have poor perceived health. The hazard for adults with perceived good health begins at the age of 30; with over 75% of adults aged between 30 – 45 being at risk of hypertension Comorbidity. From the age of 45, the hazard for hypertension Comorbidity starts to decrease with an increase in age. Interestingly, the HIV positive adults with poor perceived health were not at risk of hypertension Comorbidity at least from age 0 – 60. This is indicated by the survival curve that shows that the endpoint of interest (hypertension Comorbidity) did not occur for HIV positive adults that reported their health as poor (figure A13) .

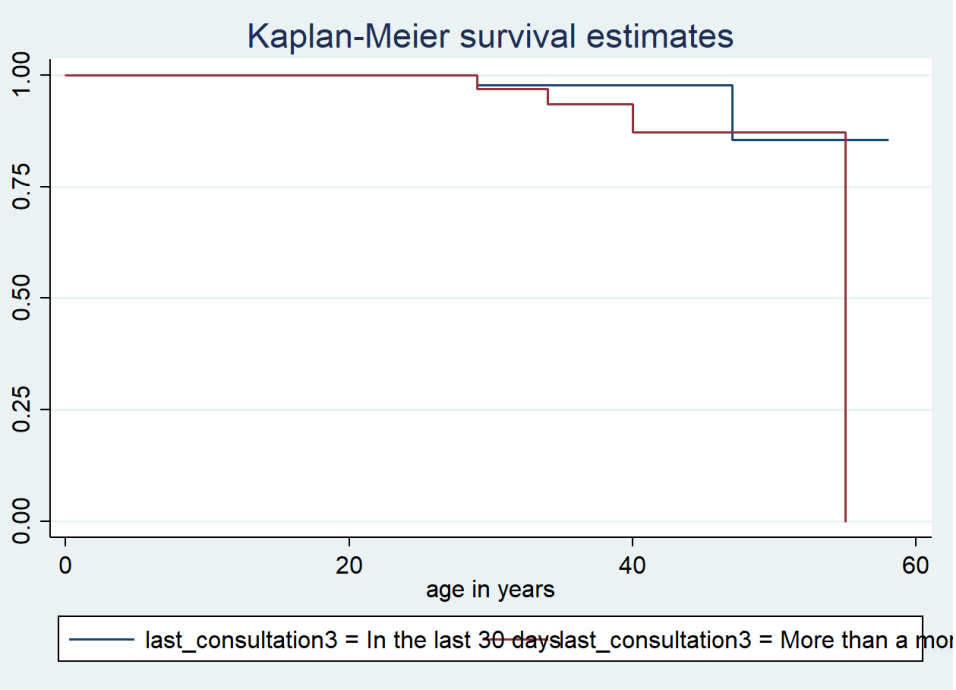

Figure A14: Hazard of hypertension Comorbidity by last doctor's consultation at wave 3

Lastly, the hazard of hypertension Comorbidity is highest among adults living with HIV that had visited a doctor more than a month ago as compared to those that had visited a doctor in the last 30 days. For adults that visited a doctor more than a month ago, the hazard of hypertension Comorbidity is highest between the age of 30 – 40. Over 80% of adults within this age group were at risk of hypertension Comorbidity. Thereafter, the hazard of hypertension Comorbidity decreases with an increase in age. With regards to adults whose last doctor's consultation was in the last 30 days, the hazard of hypertension Comorbidity also began at the 30 but declines with an increase in age thereafter (figure A14).

Wave 3: Unadjusted Cox Regression for factors associated with Hypertension Comorbidity at wave 3

Table A17: Unadjusted Likelihood Ratios of the demographic characteristics at wave 1 that are associated with hypertension Comorbidity at wave 3

Demographic characteristics	Unadjusted Hazard Ratios (p-value)	[95% Confidence Intervals]
Gender		
Female	RC	
Male	1.58 (1.000)	0
Marital status		
Never married	RC	
Married	0.70 (0.685)	0.131 - 3.809

Religion		
Other religion	RC	
Christian	1.27 (0.825)	0.146 - 11.185
Race		
Other	RC	
African	2.31 (1.000)	0
Place of residence		
Rural	RC	
Urban	1.13 (0.875)	0.226 - 5.729
Socio-economic characteristics **Employment status**		
Unemployed	RC	
Employed	1.35 (0.788)	0.147 - 12.465
Household income		
Below average income	RC	
Average income	0.49 (0.523)	0.057 - 4.280
Level of education		
No education	RC	
Some education	5.33 (-)	-
Health Behaviours/Characteristics **Tobacco use**		
No	RC	
Yes	8.75 (1.000)	0
Frequency of alcohol use		
Do not consume	RC	
At least 1nce a week	0.58 (0.666)	0.053 - 6.542
Frequency of exercise		
Never	RC	
At least once a week	0.37 (0.395)	0.038 - 3.635
Perceived health status		
Poor	RC	
Good	1.65 (0.580)	0.276 - 9.994
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	1.11 (0.925)	0.119 - 10.397

RC= reference category

Wave 4: Levels of HIV CCMs

Table A18: Prevalence of HIV CCMs at wave 4

Comorbidity Type	Weighted Frequency (N)	Percentage (%)
Hypertension		
Diagnosed	3,092.6	3.2
Undiagnosed	92,608.9	96.8
Diabetes		

Diagnosed	0	0.0
Undiagnosed	95,701.56	100.0
Cardiovascular disease		
Diagnosed	1,967.7	2.1
Undiagnosed	93,733.8	97.9
Total	**95,701.56**	**100**

Between wave 3 and wave 4, the prevalence of HIV positive adults diagnosed with hypertension Comorbidity declined from 7.2 to 3.2%. While none of the adults living with HIV (95 701) in the study developed diabetes or cardiovascular disease at wave 3, the level of cardiovascular disease Comorbidity was 2.06% at wave 4. Identifiably, while there was no new diagnosis of cardiovascular disease between 3 and 4, there is a percentage drop of 1.3 % of cardiovascular disease Comorbidity between the 2nd and 4th wave (Table A18)

Wave 4: Characteristics of HIV positive sample

Percentage and frequency distribution of the demographic, socio-economic and health characteristics of the adults diagnosed with HIV and either hypertension or cardiovascular disease at wave 4 of the NIDS Survey are presented. This is done to account for any changes in the characteristics between the third and fourth wave.

Table A19: Weighted frequencies and percentages of demographic characteristics of HIV and hypertension Comorbidity at wave 4

	Hypertension Comorbidity		
Demographic Variables	**Diagnosed N= 3 092**	**Undiagnosed N= 92 608**	**Total N= 95 701**
Age			
≤ 35 years **(%)**	0 **(0.0)**	32,297.7 **(34.9)**	32 297.1 **(33.7)**
>35 years **(%)**	3,092.6 **(100.0)**	60,311.2 **(65.1)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	3,043.9 **(98.4)**	53,487.7 **(57.8)**	56,531.6 **(59.07)**
Male **(%)**	48.6 **(1.6)**	39,121.2 **(42.2)**	39,169.8 **(40.93)**
Marital status			
Never married **(%)**	3,092.6 **(100.0)**	73,488.3 **(79.4)**	76,581.0 **(80.0)**
Married **(%)**	0 **(0.0)**	19,120.5 **(20.6)**	19,120.5 **(20.0)**
Religion			
Other religion **(%)**	886.8 **(28.7)**	25,520.6 **(27.6)**	26,407.4 **(27.6)**
Christian **(%)**	2,205.8 **(71.3)**	67,088.2 **(72.4)**	69,294.0 **(72.4)**
Race			
Other (%)	0 **(0.0)**	4,393.9 **(4.7)**	4,393.9 **(4.6)**
African (%)	3,092.6 **(100.0)**	88,214.9 **(95.3)**	91,307.6 **(95.4)**
Place of residence			
Rural **(%)**	323.4 **(10.5)**	34,551.6 **(37.3)**	34,875.1 **(36.4)**

Urban **(%)**	2,769.2 **(89.5)**	58,057.2 **(62.7)**	60,826.4 **(63.6)**

Of the 3 092 adults with HIV and hypertension Comorbidity at wave 4, all were aged above 35 years old (100%), the majority were male (98.4%), all were married (100%), mostly Christian (71,3%), predominately Black Africans (100%) and the majority were residing in urban areas of South Africa (89.5%) (Table A19) .

Table A20: Weighted frequencies and percentages of the Socio-economic characteristics of HIV positive adults by hypertension Comorbidity at wave 4

	Hypertension Comorbidity		
Socio-economic Variables	**Diagnosed N= 3 092**	**Undiagnosed N= 92 608**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	3,092.6 **(100.0)**	80,245.7 **(86.6)**	83,338.3 **(87.1)**
Employed **(%)**	0 **(0.0)**	12,363.1 **(13.4)**	12,363.1 **(12.9)**
Household income			
B/low average **(%)**	2,287.1 **(74.0)**	40,375.0 **(43.6)**	42,662.1 **(44.6)**
Average (**%)**	805.5 **(26.0)**	52,233.8 **(56.4)**	53,039.4 **(55.4)**
Education level			
No education **(%)**	1,998.7 **(64.6)**	46,414.2 **(50.1)**	48,413.0 **(50.6)**
Some education **(%)**	1,093.8 **(35.4)**	46,194.6 **(49.9)**	47,288.4 **(49.4)**

In terms of socio-economic status, the largest proportion of adults living with HIV and hypertension Comorbidity are unemployed (100%), with a low household income (73.9%) and only about a third have received some form of education (35.3%) (Table A20).

Table A21: Weighted frequencies and percentages of the of Health behaviour characteristics of HIV positive adults by hypertension Comorbidity at wave 4

	Hypertension Comorbidity		
Health behaviour Variables	**Diagnosed N= 3 092**	**Undiagnosed N= 92 608**	**Total N= 95 701**
Tobacco use			
No **(%)**	2,335.8 **(75.5)**	81,002.4 **(87.5)**	83,338.2 **(87.1)**
Yes **(%)**	756.8 **(24.5)**	11,606.4 **(12.53)**	12,363.3 **(12.9)**
Alcohol use			
Do not drink **(%)**	2,015.7 **(65.2)**	76,296.6 **(82.4)**	78,312.4 **(81.8)**
Few times a month **(%)**	1,076.8 **(34.8)**	16,312.2 **(17.6)**	17,389.1 **(18.2)**
Exercise			
Never **(%)**	3,092.6 **(100.0)**	69,769.9 **(75.3)**	72,862.6 **(76.1)**
Once a week **(%)**	0 **(0.0)**	22,838.9 **(24.7)**	22,838.9 **(23.9)**
Perceived Health			
Poor **(%)**	337.0 **(10.9)**	19,313.2 **(20.9)**	19,650.2 **(20.5)**
Good **(%)**	2,755.6 **(89.1)**	73,295.7 **(79.2)**	76,051.3 **(79.5)**
Last Dr consultation			

Last 30 days **(%)**	2,015.7 **(65.2)**	35,772.2 **(38.6)**	37,788.0 **(39.5)**
1 month + ago **(%)**	1,076.8 **(34.8)**	56,836.6 **(61.4)**	57,913.4 **(60.5)**

With regards to health behaviours, only about 24.4% of HIV positive adults diagnosed with hypertension Comorbidity smoked tobacco. A large proportion (65.1%) said they did not drink alcohol, and all said they never exercise (100%). The majority reported to have good health (89.1%) and most said that their last doctor's visit occurred in the last 30 days (81.2%) (Table A21).

Table A22: Weighted frequencies and percentages of demographic characteristics of HIV and cardiovascular disease Comorbidity at wave 4

	Cardiovascular Disease Comorbidity		
Demographic Variables	**Diagnosed N= 1 967**	**Undiagnosed N= 93 733**	**Total N= 95 701**
Age			
≤ 35 years **(%)**	0 **(0.0)**	32,297.7 **(34.5)**	32 297.1 **(33.7)**
>35 years **(%)**	1,967.7 **(100.0)**	61,436.1 **(65.5)**	63 403.8 **(66.2)**
Gender			
Female **(%)**	1,967.7 **(100.0)**	54,563.9 **(58.2)**	56,531.6 **(59.1)**
Male **(%)**	0 **(0.0)**	39,169.8 **(41.8)**	39,169.8 **(40.9)**
Marital status			
Never married **(%)**	0 **(0.0)**	76,581.0 **(81.7)**	76,581.0 **(80.0)**
Married **(%)**	1,967.7 **(100.0)**	17,152.8 **(18.3)**	19,120.5 **(20.0)**
Religion			
Other religion **(%)**	0 **(0.0)**	26,407.4 **(28.2)**	26,407.4 **(27.6)**
Christian **(%)**	1,967.7 **(100.0)**	67,326.3 **(71.8)**	69,294.0 **(72.4)**
Race			
Other (%)	0 **(0.0)**	4,393.9 **(4.7)**	4,393.9 **(4.6)**
African (%)	1,967.7 **(100.0)**	89,339.9 **(95.3)**	91,307.6 **(95.4)**
Place of residence			
Rural **(%)**	0 **(0.0)**	34,875.1 **(37.2)**	34,875.1 **(36.4)**
Urban **(%)**	1,967.7 **(100.0)**	58,858.7 **(62.8)**	60,826.4 **(63.6)**

Of the 1 967 adults with HIV and cardiovascular disease Comorbidity at wave 4, all are aged above 35 years old (100%), male (100%), married (100%), Christian (100%), black Africans (100%) and all were residing in urban areas of South Africa (100%) (Table A22).

Table A23: Weighted frequencies and percentages of the Socio-economic characteristics of HIV positive adults by cardiovascular disease Comorbidity at wave 4

	Cardiovascular disease Comorbidity		
Socio-economic Variables	**Diagnosed N= 1 967**	**Undiagnosed N= 93 733**	**Total N= 95 701**
Employment status			
Unemployed **(%)**	1,967.7 **(100.0)**	81,370.6 **(86.8)**	83,338.3 **(87.1)**
Employed **(%)**	0 **(0.0)**	12,363.1 **(13.2)**	12,363.1 **(12.9)**

Household income			
B/low average **(%)**	0 **(0.0)**	42,662.1 **(45.5)**	42,662.1 **(44.6)**
Average (**%)**	1,967.7 **(100.0)**	51,071.7 **(54.5)**	53,039.4 **(55.4)**
Education level			
No education **(%)**	1,967.7 **(100.0)**	46,445.3 **(49.6)**	48,413.0 **(50.6)**
Some education **(%)**	0 **(0.0)**	47,288.4 **(50.4)**	47,288.4 **(49.4)**

In terms of socio-economic status, all the adults living with HIV and CVD Comorbidity are unemployed (100%), with an average household income (100%) and all had no education (100%) (Table A23).

Table A24: Weighted frequencies and percentages of the of Health behaviour characteristics of HIV positive adults by hypertension Comorbidity at wave 4

Cardiovascular disease Comorbidity			
Health behaviour Variables	**Diagnosed N= 1 967**	**Undiagnosed N= 93 733**	**Total N= 95 701**
Tobacco use			
No **(%)**	1,967.7 **(100.0)**	81,370.5 **(86.8)**	83,338.2 **(87.1)**
Yes **(%)**	0 **(0.0)**	12,363.3 **(13.2)**	12,363.3 **(12.9)**
Alcohol use			
Do not drink **(%)**	1,967.7 **(100.0)**	76,344.6 **(81.4)**	78,312.4 **(81.8)**
Few times a month **(%)**	0 **(0.0)**	17,389.1 **(18.6)**	17,389.1 **(18.2)**
Exercise			
Never **(%)**	1,967.7 **(100.0)**	70,894.9 **(75.6)**	72,862.6 **(76.1)**
Once a week **(%)**	0 **(0.0)**	22,838.9 **(24.4)**	22,838.9 **(23.9)**
Perceived Health			
Poor **(%)**	0 **(0.0)**	19,650.2 **(20.9)**	19,650.2 **(20.5)**
Good **(%)**	1,967.7 **(100.0)**	74,083.6 **(79.1)**	76,051.3 **(79.5)**
Last Dr consultation			
Last 30 days **(%)**	1,967.7 **(100.0)**	35,820.3 **(38.2)**	37,788.0 **(39.5)**
1 month + ago **(%)**	0 **(0.0)**	57,913.4 **(61.8)**	57,913.4 **(60.5)**

With regards to health behaviours, all of the HIV positive adults diagnosed with cardiovascular disease Comorbidity did not smoked tobacco (100%). All said they did not drink alcohol and never exercise (100%). In addition, all reported to have good health (100%) and said that their last doctor's visit occurred in the last 30 days (100%) (Table A24).

Wave 5: Time to hypertension Comorbidity by selected demographic, socio-economic and health characteristics

Kaplan survival estimates were again used to show the differences in the demographic, socio-economic and health-related characteristics of the HIV positive adults that developed

hypertension Comorbidity. The survival curves presented here are only of the characteristics of adults living with HIV and hypertension Comorbidity that were most prevalent in the percentage distribution at wave 3.

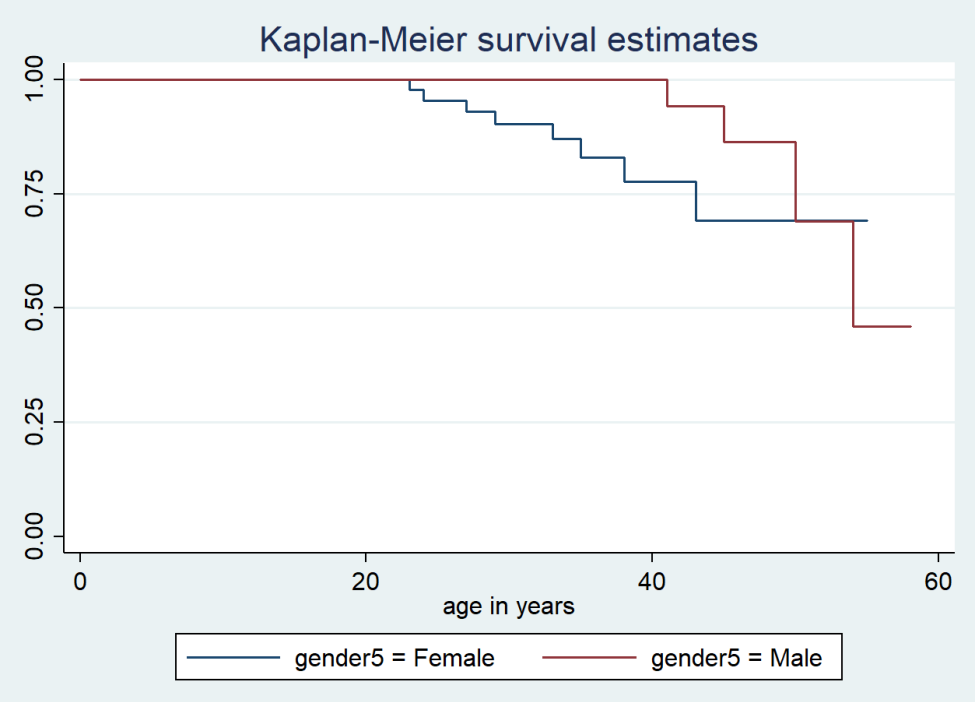

Figure A15: Hazard of hypertension Comorbidity by gender at wave 5

Figure A15 shows that hypertension Comorbidity is highest among females as compared to males, with the risk being highest between the ages of 25 – 38 years old. Over 75% of HIV positive females in this age group were at risk of hypertension Comorbidity. Identifiably, this survival curve depicts those females living with HIV develop hypertension much earlier than males. The risk of hypertension Comorbidity for males living with HIV begins from the age of 40; with risk being highest between age 40 – 45. Over 80% of males in this age group were at risk of hypertension Comorbidity. From the age of 40, the hazard of hypertension Comorbidity begins to decline with an increase in age.

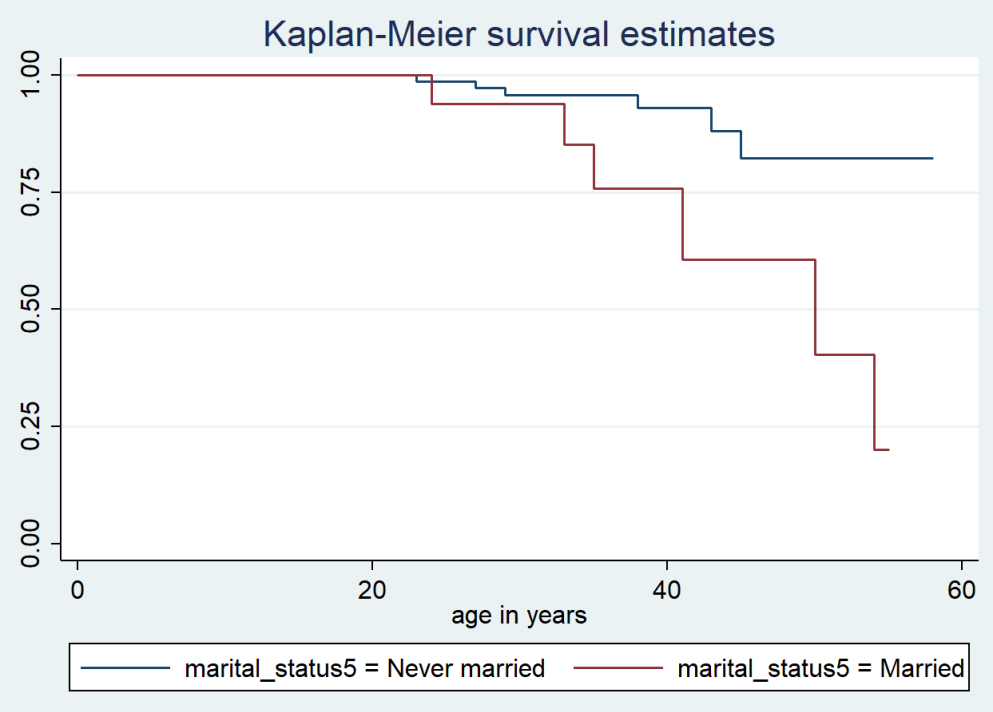

Figure A16: Hazard of hypertension Comorbidity by marital status at wave 5

With regards to marital status, the hazard for hypertension Comorbidity for adults living with HIV is highest for adults that have never been married as compared to those that have been married; with hazard being highest between the age of 25 – 30 years old. The hazard begins to decrease with an increase in age from the age of 30. However, the risk remains high even at the age of about 42 – 45; with over 75% of never married HIV positive adults being at risk of hypertension Comorbidity. For married adults, the hazard of hypertension Comorbidity is highest at the age of about 28. Thereafter, the hazard decreases with an increase in age; dropping to about only 23% from the age of 55 (figure A16).

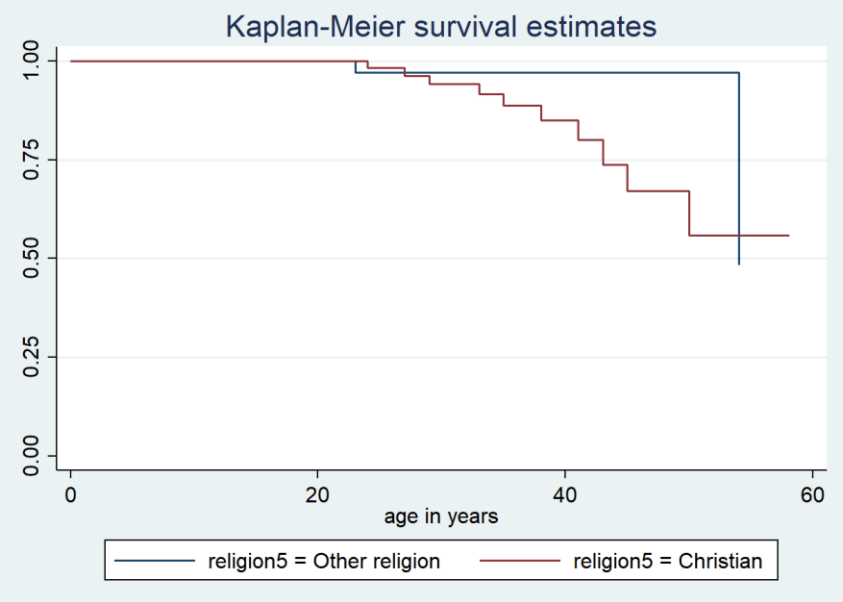

Figure A17: Hazard of hypertension Comorbidity by religion at wave 5

According to figure A17, the risk of hypertension Comorbidity begins slightly at the same age for both HIV positive adults that are Christian and non- Christian; with risk beginning at the age of about 25 – 26. However, the hazard of hypertension Comorbidity is highest for Christians as compared to HIV positive adults from other religions; with risk being highest between age 26 – 45. Over 70% of HIV positive adults that are Christian were at risk of developing hypertension Comorbidity within this age group. From the age of 45, the hazard of hypertension Comorbidity begins to decrease with an increase age for Christians.

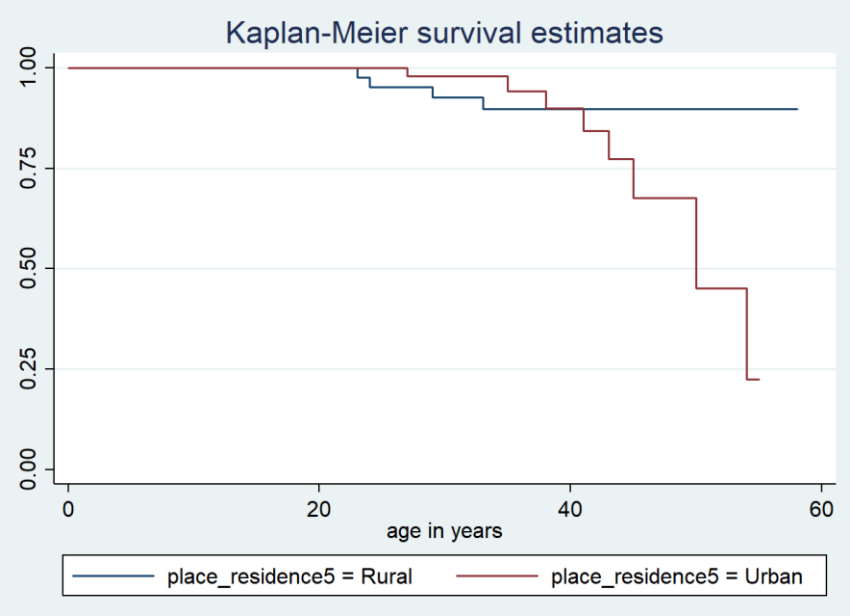

Figure A18: Hazard of hypertension Comorbidity by place of residence at wave 5

Figure A18 above depicts that hypertension Comorbidity occurs much earlier for HIV positive adults residing in rural areas; at the age of about 25. Over 80% of these adults were at risk of

hypertension Comorbidity. However, from the age of 25, the hazard of hypertension Comorbidity begins to slightly decrease with an increase in age. Identifiably, the hazard of hypertension Comorbidity begins at the age of about 30 and is highest between 35 – 45. Over 70% of HIV positive adults in urban areas were at risk of hypertension Comorbidity. Thereafter the risk of hypertension Comorbidity begins to decrease with an increase in age.

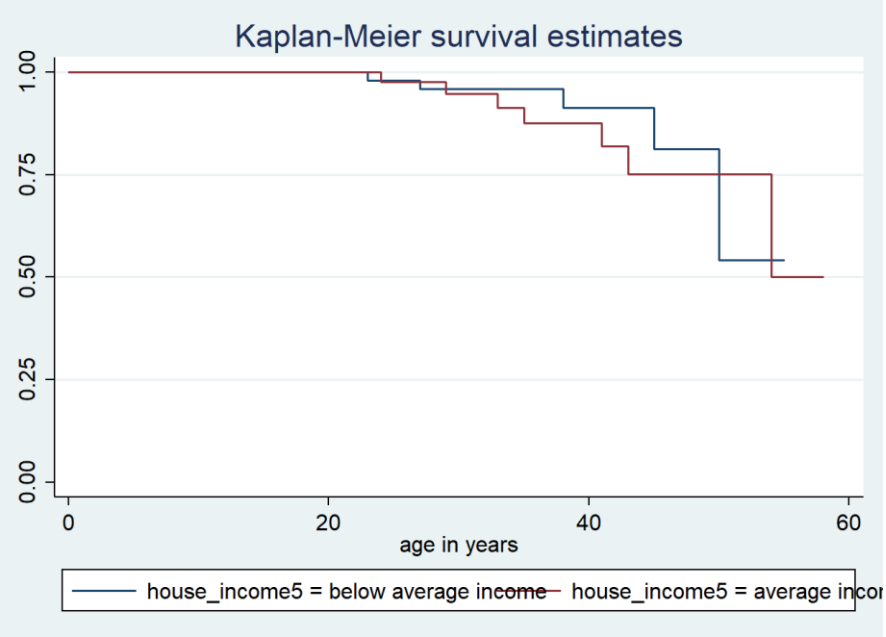

Figure A19: Hazard of hypertension Comorbidity by household income at wave 5

According to figure A19, hypertension Comorbidity is highest for HIV positive adults with an average household income as compared to those who have a below average household income; with hazard being highest between the age of 25 – 45. Over 75% of HIV positive adults within this age group from households with an average household income were at risk of hypertension Comorbidity. After the age of 45, the hazard begins to decline with an increase in age. For adults with a below average household income, is highest between the age 25 – 30. Thereafter, the risk begins to decline with an increase in age.

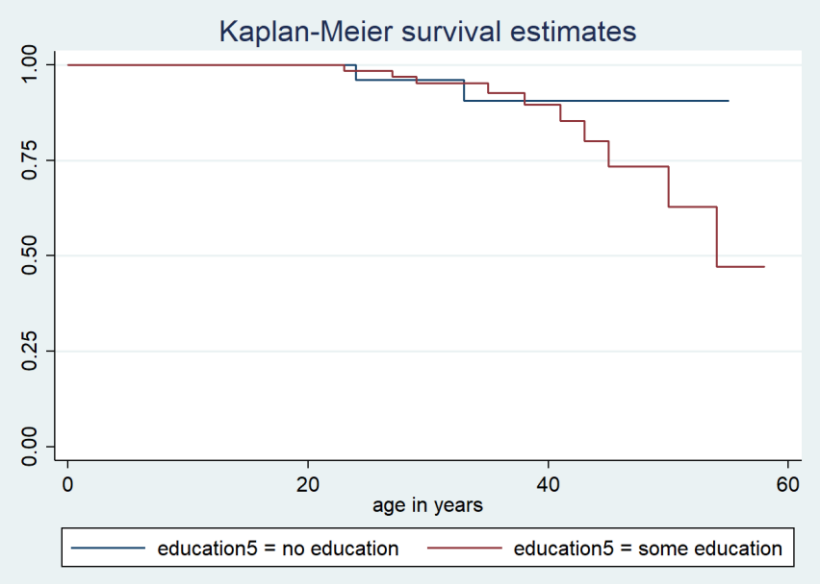

Figure A20: Hazard of hypertension Comorbidity by level of education at wave 5

Concerning level of education, the risk of hypertension Comorbidity is highest for HIV positive adults with some education as compared to those with no education; with risk being highest between age 25 and 45. Over 75% of adults with some education and aged within this age group were at risk of hypertension Comorbidity. From the age of 45, the risk for hypertension Comorbidity begins to decline with an increase in age. For adults with no education, the risk of hypertension Comorbidity is highest between the ages of 30 and 35. However, from the age of 35, the risk declines for this sample with an increase in age (figure A20).

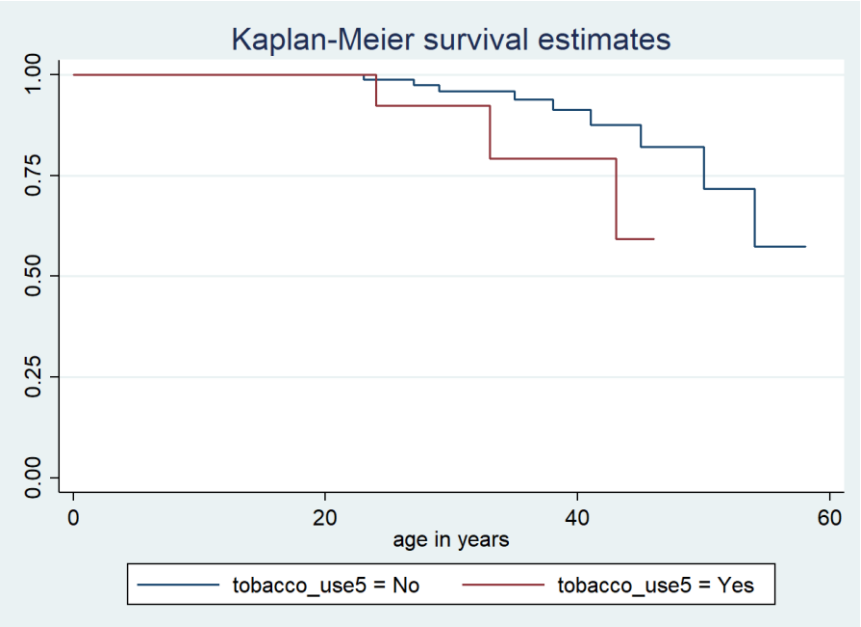

Figure A21: Hazard of hypertension Comorbidity by tobacco use at wave 5

The survival curve in figure A21 shows that hypertension Comorbidity is highest for adults living with HIV that do not smoke tobacco as compared to those that smoke. The hazard for

adults that do not smoke is highest between the age of 25 – 45. Over 80% of adults living with HIV within this age group were at risk of hypertension Comorbidity. From the age of 45, the hazard of hypertension begins to decrease with an increase in age. For adults that smoke, the hazard is highest between the age of 28 – 30, however the risk begins to decline with an increase in age.

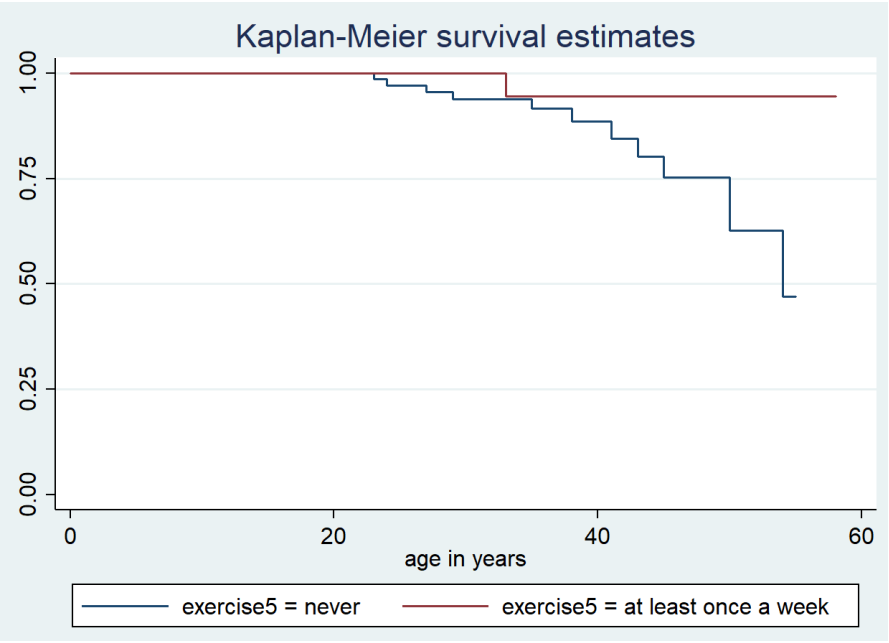

Figure A22: Hazard of hypertension Comorbidity by frequency of exercise at wave 5

According to figure A22, the hazard of hypertension Comorbidity is highest for HIV positive adults that never exercise as opposed to those that exercise at least once a week; with hazard being highest between the age of 25 – 45. Over 75% of HIV positive adults that do not exercise were at risk of hypertension Comorbidity between this age group. From the age of 45, the hazard of hypertension Comorbidity begins to decline with an increase in age for this sample. With regards to adults that exercise at least once a week, the hazard for hypertension Comorbidity occurred at age 30. Thereafter, the hazard decreases with an increase in age.

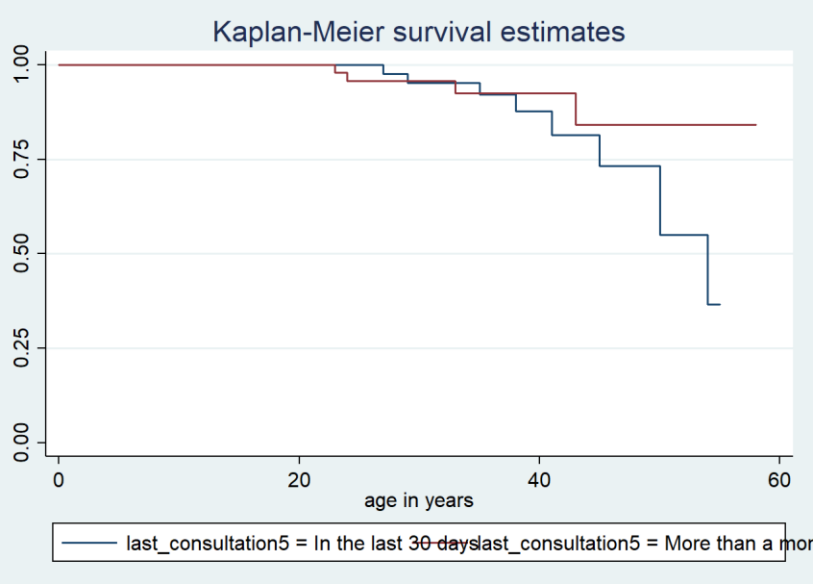

Figure A23: Hazard of hypertension Comorbidity by last doctor consultation at wave 5

Lastly, the hazard of hypertension Comorbidity is highest among adults living with HIV whose last doctor's consultation was 30 days ago as compared to those that had visited a doctor more than a month ago. For these adults, the hazard was highest between the age 30 – 40. From the age of 40, the hazard begins to decrease with an increase in age, dropping to about 30% by the age of 55. For adults that visited a doctor more than a month ago, the hazard of hypertension Comorbidity is highest between the age of 25 - 28. Thereafter, the hazard of hypertension Comorbidity decreases with an increase in age. However, the hazard remains high even between the ages of 30 – 45; with over 75% still being at risk (figure A23).

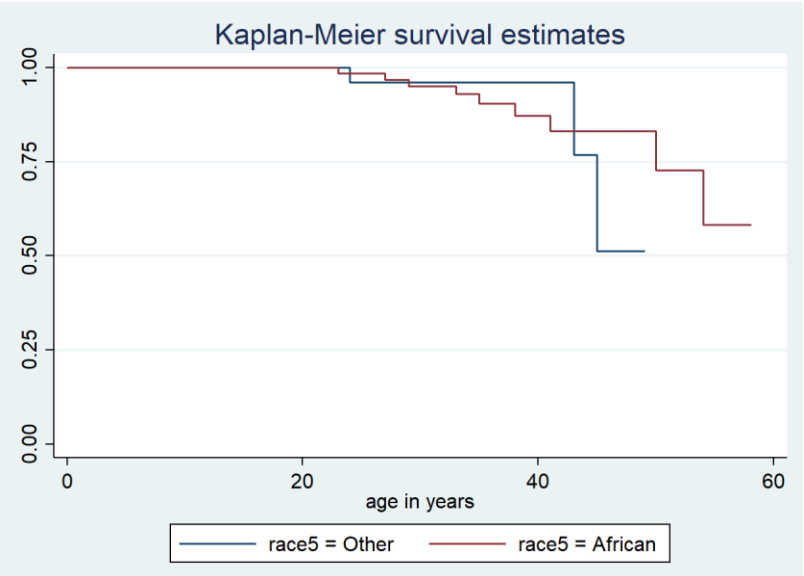

Figure A24: Hazard of hypertension Comorbidity by race at wave 5

In terms of race, the hazard of hypertension Comorbidity is highest for Black African adults diagnosed with HIV as compared to adults from other races. As depicted, the hazard for the

Black African race group begins at the age of 25 and is highest between the age of 25 – 40. For example, over 80% of HIV positive black Africans were at risk of hypertension Comorbidity between this age group. From the age of 40, the hazard of hypertension Comorbidity begins to decrease with an increase in age, dropping to about 55% at by the age of 55 (figure A24)

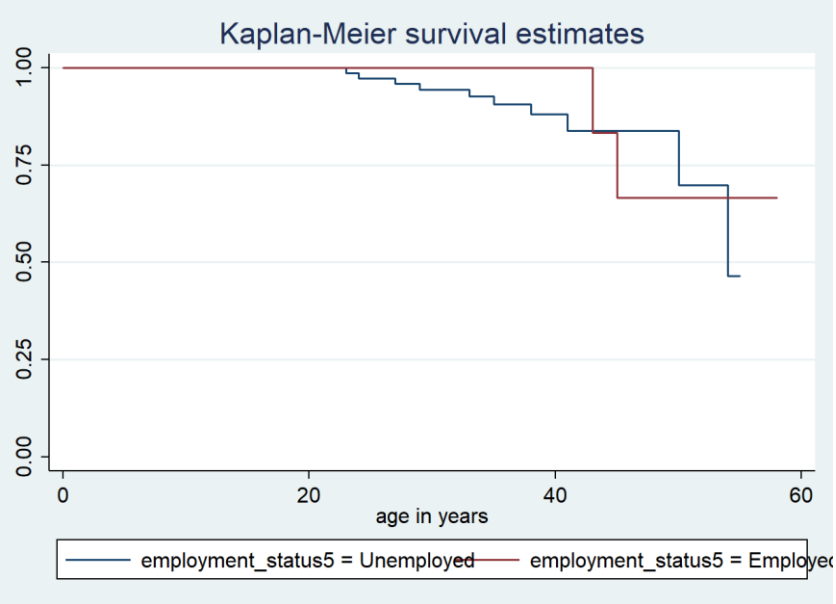

Figure A25: Hazard of hypertension Comorbidity by employment status at wave 5

With regarding to employment status, the survival curve shows that the hazard of hypertension Comorbidity is highest for HIV positive adults that are unemployed as compared to those that are employed; with the hazard being highest between age 25 – 40. Over 80% of HIV positive adults that were unemployed and in this age group were at risk of developing hypertension Comorbidity. From the age of 40, the hazard begins to decline and only after the age of 55 does the hazard drop to about 55%. For adults that are employed, the hazard occurs from the age of about 45 and declines with an increase in age thereafter (figure A25)figure .

Wave 5: Unadjusted Cox Regression for factors associated with Hypertension Comorbidity at wave 5

Table A25: Unadjusted Likelihood Ratios of the demographic characteristics at wave 3 that are associated with hypertension Comorbidity at wave 5

Demographic characteristics	Unadjusted Hazard Ratios (p-value)	[95% Confidence Intervals]
Gender		
Female	RC	
Male	0.38 (0.108)	0.123 - 1.230
Marital status		
Never married	RC	
Married	1.65 (0.417)	0.489 - 5.633

Religion		
Other religion	RC	
Christian	2.04 (0.223)	0.646 - 6.500
Race		
Other	RC	
African	7.77 (1.000)	0
Place of residence		
Rural	RC	
Urban	0.63 (0.443)	0.203 - 2.007
Socio-economic characteristics **Employment status**		
Unemployed	RC	
Employed	1.69 (0.392)	0.508 - 5.632
Household income		
Below average income	RC	
Average income	2.06 (0.218)	0.651 - 6.551
Level of education		
No education	RC	
Some education	2.86 (0.176)	0.623 - 13.135
Health Behaviours/Characteristics **Tobacco use**		
No	RC	
Yes	0.583 (0.617)	0.070 - 4.815
Frequency of alcohol use		
Do not consume	RC	
At least 1nce a week	1.38 (0.678)	0.296 - 6.507
Frequency of exercise		
Never	RC	
At least once a week	2.17 (0.217)	0.633 7.453
Perceived health status		
Poor	RC	
Good	1.65 (0.412)	0.496 - 5.518
Last doctor consultation		
In the last 30 days	RC	
1 month + ago	1.85 (0.294)	0.586 - 5.847

RC= reference category

APPENDIX B: Additional Qualitative findings

Sequence of Chronic disease diagnosis

It was established that chronic conditions such as hypertension and diabetes at times precede the diagnosis of HIV.

> *"90% of the time they start by having DM first before HIV…and being diabetic does not pre-dispose you to being HIV positive……but HPT and DM have a cousin relationship, you know someone who started with Hypertension five years down the line that patient is going to be diabetic…but HIV and chronic alignment, No!"*
>
> ***Dr, EC.***

> *"Sometimes it is vice versa because there are others who have been on hypertension treatment then later, they are HIV positive so it Is not always whereby we can say she got hypertension because she is HIV positive."*
>
> ***Professional Nurse, GP.***

> *"It can be vice versa…whereby it is going to be hypertension and then HIV…and in most cases you find out that they are already hypertensive patients and all of a sudden they develop HIV."*
>
> ***Registered Nurse, GP.***

> *"Most of the time what I have found with these patients, most of them they get diagnosed with HIV at a very late stage of the diseases…they only found out because there was something else like hypertension…when we have that person with a high BP, we want to check holistically what else is there."*
>
> ***Professional Nurse, GP.***

Causes/Risk Factors

For patients that develop chronic conditions after being diagnosed with HIV, HCWs were asked about some of the main causes and risk factors leading to the chronic conditions among patients living with HIV. The major sub-themes arising from their inputs were stress; lifestyle, increased life expectancy, genetics, and the Use of Antiretroviral Treatments (ART).

Stress: McEwan & Sapolsky 2006 define stress as pressure or strain that can result adverse physical, emotional or psychological effects (McEwen & Sapolsky, 2006). HCWs reported that many of their patients suffered psychological stress emanating from:

1. Acceptance/denial of HIV diagnosis
2. Stigma
3. Decisions regarding disclosure.

The HCWs reported a direct link between these stressors and increased blood pressure, leading to hypertension. Further mentioning that uncontrolled hypertension often leads to diabetes and other chronic conditions such as cancer.

"it's mostly stress, the minute they find out that they are HIV positive they become stressed up…and let's say you come in today for flu or something like coughing, I test you and tell you have HIV, and you know you only have one partner, that's stressful."

Professional Nurse 1, GP.

"Most of them will tell you they are stressed but I feel that it is related to that stigma outside, hence they don't want to tell people that they are diagnosed with HIV."

Professional Nurse, EC.

"I think maybe it is stress because stress can immediately trigger the blood pressure. You have adults that are diagnosed today and start asking themselves questions like: 'where did I get this sickness? And while the patient is still thinking how did she get this HIV you are telling her to start treatment."

Professional Nurse 2, GP.

"Most of the times it is the stress that comes with knowing their status."

Professional Nurse, GP.

"I think it's stress because of the stigma and because of the condition they have…some of them have stress due to poverty at home."

Professional Nurse, GP.

"In cases whereby they develop hypertension it can be due to stress…If it was first HIV and then hypertension it's because the patient was not coping or unable to adapt or not being able to acknowledge or being in denial of their status."

Registered Nurse, GP.

"We need to monitor their stress level each and every time to find out have they disclosed their HIV status to someone, are they keeping it to themselves or what…because if they are keeping it to themselves, they start to stress and commit suicide because they are taking all of these things to heart."

Registered Nurse, GP.

"Mostly you find that the patient has underlying stressors and those that lead to hypertension…underlying stressors like disclosure."

Professional Nurse, GP.

Unhealthy Lifestyle: Lifestyle refers to characteristics and day to day behaviours, activities and practices of an individual or groups of people; which may have a significant impact on the mental and physical being (Farhud, 2015). Smoking, alcohol use, poor diet and lack of exercise are the presentations of unhealthy lifestyles spoken of by HCWs that lead to the diagnosis of additional chronic conditions in adults living with HIV.

"I think the way we live, most of the time we don't watch what we eat, we don't care about exercising so I think those are reasons why they (HIV positive adults) would also develop hypertension or diabetes."

Professional Nurse, EC.

"Risk factors like sedentary lifestyle, overweight, environmental factors, nutrition. Most of these things, especially hypertension and diabetes, are related to lifestyle."

Dr, EC.

"Most of the time they have to do with the lifestyle the person lives…unhealthy eating, obesity."

Professional Nurse, EC.

"You find that most of the time their lifestyle also causes the bizarre increase to the sickness, you know they drink a lot, they smoke."

Professional Nurse, GP.

"They smoke and drink too much."

Professional Nurse, EC.

"Some are not eating healthy foods."

Professional Nurse, GP.

"Ignorance kicks in because when they have a little bit of money say maybe R5 the only think they think about is to buy fat cakes or kota (bunny-chow) instead of cooking."

Professional Nurse 1, GP.

"The minute they find out that they are positive they relax, and they just eat anything and that don't exercise."

Professional Nurse 2, GP.

"It's usually lifestyle, lack of exercise and eating healthy… obesity is one the predisposing factors for diabetes."

DR, EC.

"Sometimes it is diet or lack of exercise" registered nurse."

Professional Nurse, GP.

Increased life expectancy: Life expectancy refers to the average number of years remaining to be lived for an individual, at a specific age. Some of the doctors interviewed shared the view that the rise in chronic conditions among PLWH is because of progress made with antiretroviral treatments that has allowed for this group of adults to live longer and, therefore, experience chronic conditions that would affect any other adult as s/he aged.

"I think previously the lifespan of people with HIV was quite short so they wouldn't live that long to get diabetes and all those other things so now because of ART their lifespan is longer."

Dr, EC.

"The older people, they are the ones that mostly present with the co-morbidities of HPT and DM, the young ones most of the time they have HIV, then the co-morbidities that they have are complications of HIV like renal failure."

Dr, EC.

Genetics: Genes are inherited characteristics and/or properties that are transferred from one generation to another, often through parental fluids that intermix with the offspring (Susman, 2005). Irrespective of their HIV status, the risk of chronic disease among PLWH is said be because of patient's family history of conditions such as hypertension, diabetes, and cancer.

"It's because of their lifestyle but some you find that its family history."

Professional Nurse, EC.

"For some like DM, 90% of the time its genetically so there is very minimal that you can do."

Dr, EC.

"When you talk about hypertension you may find that they develop it because it is just the age or maybe it is genetically, registered nurse."

Professional nurse, GP.

"I think hypertension is more of a common chronic disease because of the genes."

Professional Nurse, GP.

"Sometimes its heredity…you will find a patient will say my mother has hypertension and grandmother is also taking the tablets."

Professional Nurse, EC.

Use of ART: Antiretroviral treatment is the medication that is/should be provided to HIV positive individuals with a CD4 count >350 and ≤ 500/mm (World Health Organisation, 2013). Currently there are six categories of HIV treatment drugs. Namely: Nucleoside-analog reverse transcriptase inhibitors (NRTIs), Non-Nucleoside-analog reverse transcriptase inhibitors (NNRTIs), Integrase inhibitors, protease inhibitors (PIs), Fusion inhibitors and Coreceptor antagonists (Arts & Hazuda, 2012). Within each category, there are various medicines, with some categories having up to nine different tablets. (Arts & Hazuda, 2012). HCWs reported that there is no link between the use of ART and either hypertension or diabetes (most prevalent reported conditions). However, the use of some of these drugs is reported to at least lead to chronic kidney disease among PLWH.

"None of the drugs in the first line or second line ART I know predisposes people to get diabetes or hypertension…HIV causes chronic kidney disease, that treatment itself Tenofovir is kidney toxic, so a lot are unmonitored closely in clinics so they end up with Tenofovir kidney toxicities and end stage renal disease."

DR, EC.

"I don't really think DM or HPT are HIV related…it just happens that those individuals are also at high risk of having chronic disease."

Dr, EC.

"I don't think hypertension is related to HIV; I think anybody can develop hypertension even if they are not HIV positive."

Professional Nurse, EC.

Family and Social Support

This study found that outside of the clinical setting, participants often receive support to manage their conditions from family, friends and colleagues that they have disclosed to. The support provided is often emotional support that encourages them to take their medication and remain positive about life and the future.

"My husband is my pillar of strength and even my co-worker friend is very supportive."

P6, EC.

"I disclosed to my children, and nothing changed them from being caring and loving."

P6, EC.

"I have a lady that I speak to and share with, as I was suffering, she was always supporting me and gave me words of encouragement to take it as it was…that helped me a lot towards my recovery."

P7, EC.

"I get supported by my family; they are my pillar of strength."

P8, EC.

"At home, they were very understanding they didn't have any stress…Both my brothers are aware, and they really do try to support me, they encourage a lot."

P1, GP.

"I have some few friends who are also positive…we speak about most things and from them I get enough support…but overall, I am my own pillar you know. That is why even with some of the things like my two chronic I cannot share them with everyone…I only share with those two or three people that I know that you know they are there and if those people are not there I am going to fall apart."

P12, GP.

"There are those that are supportive…the people I live with; I have people I told; those are the people I know what kind of people are they. Well they were very understanding; they even spoke to me and encouraged me saying that this doesn't mean it is the end of life.…but you know in families people are not the same…the support I receive is better from the children…shame my children are very supportive and close to each other because even the time I told my niece she said "oh well aunty you might find that you have it and you don't know, its hiding…they treat it like it's not the end of the world…Another thing is, I am close to people I fellowship with at church, because when you tell them they say "age that's nothing, you know God allows some things to happen."

P2, GP.

"There was a time when I used to work in town with this lady, she told me and at that time I didn't have these conditions, I was a supervisor there, so she said to me when you see me go out every time at 8 o'clock I go to buy something to eat because at 8 it's time for me to drink my pills and she even showed them to me and she said its pills for this thing... I said well there is nothing wrong with that, you must take your pills and you should never take them on an empty stomach."

P2, GP.

"You know as we speak if it was not for my second child, the one after my late first born, I am sure I would have long died because shame he is always persuading me to take my medication. I had told myself that I will

totally not take the high blood pills. He is always encouraging me to take them saying "mama drink, drink them" but hey with a heavy heart I drink them… the old lady I look after is very supportive. She always encourages me to eat because she says she know how high blood is. Whenever I am with her I become free, it's like she knows and understands my situation."

P3, GP.

Outlook on life after diagnosis of HIV CCM

Most of the study participants in this study had accepted their health conditions and showed to have a positive attitude towards taking care of themselves and managing their conditions. For some, management involved taking their prescribed medication, having a positive outlook on life despite being diagnosed with chronic illnesses, prayer, and meditation,

"What can I say, it is not easy, but it is what it it…life has to move on either way…All I have to do is to protect myself, so I do not get worse or get other conditions,"

P7, EC.

"I have accepted that this is how I am going to spend the rest of my life, so nothing is stressing me in terms of accepting…I am at a point where I can accept anything, and I don't allow anything to stress me…This has also made it easier for me to accept even when I tested positive for high blood. I can accept anything even if I was told that I have cancer I would accept it."

P1, GP.

"When I discovered about my hypertension it didn't stop me from doing anything. I would be out until 3 o'clock in the morning or 2 o'clock and the next thing my shuttle would be here, and I just came back, you know life was going on. I would get to work with hangover [laughs] but you know life was going and I had to take my hypertension medication you know, yes life was just going on. And now that I have another condition added I can say it has drastically changed… I don't engage in any of these things anymore…And I don't want to find myself defaulting and all of that, and I don't want to carry the pills whenever I go out all the time."

P12, GP.

"Personally, even though I haven't had that problem, a time comes when I say to myself eish Lord I have these two things, though I have not yet had problems that much that are bothering me because physically I am alright."

P2, GP.

"Since ever I started drinking ARVs to the people in my community I was never anything to them. But I told myself that this is my life I don't care what any person says…personally I encourage myself, I tell myself that you only live once; I have to encourage myself and drink my pills on time and do what I am told to do. That will see me having a long life so I can be able to raise my grandchildren. Somebody can encourage you just for the sake of doing you a favour but when you encourage yourself and tell yourself that you are content with what God has given you. You will go forward with life."

P3, GP.

"Well personally I don't have too much problems because I try to live my normal life and avoid worries about this and that…Sometimes you find that you don't know exactly what you should do except for the advises from the nurses and the doctors…the knowledge that I have It's not much but I know how to live my life and survive in the current situation."

P4, GP.

APPENDIX C: Research Tools – Questionnaires

Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study

Semi-structured Interview Guide for Participants living with HIV and other chronic conditions in South Africa

Adult Questionnaire

Thank you for taking the time to participate in this study. Please note that your participation is completely voluntary, and you can withdraw at any time without consequences.

Objective: To understand the challenges regarding treatment and access to healthcare faced by adults with HIV chronic co-morbidities in South Africa.

Interviewee Information

Section A: Demographic Information

I would like to begin by collecting some demographic information. The questions in this section are used to determine whether you fit into the population group that this study is interested in as well as to understand some characteristics that can tell me more about who you. Please can you answer the following set of questions:

What is your:

1. Age:
2. Sex:
3. Race:
4. Highest Level of education:
5. Current Employment status:
6. Current Marital status:
7. Do you smoke?
8. Do you consume/drink alcohol?

Section B: Diagnosis

Again, the next set of questions are aimed at further understanding whether you fit into the study criteria. As well as providing me with more depth regarding living with HIV CCMs. Please remember that the responses you give me are confidential and will only be used for the purpose of this study.

1. **Do you know your HIV status?**
2. **How long have you been living with HIV?**

   Probe: Year

3. **Are you on Antiretroviral Treatment (ART)?**

   ART refers to the medication (ARV drugs) that you are given to manage HIV such that you may live longer.

4. **In which year where you first initiated on ART?**
5. **In addition to HIV, have you been diagnosed with an additional chronic condition?**

   If yes, what type of additional chronic condition do you have?

   Probe: list (hypertension, diabetes, cancer, heart disease, asthma, stroke, depression).

6. **Can you remember in which year you were diagnosed with ……(mention chronic condition mentioned Q5 above).**
7. **Do you take treatment for this chronic condition (mention chronic condition mentioned in Q5 above).**
8. **What treatment or care do you receive for your condition (HIV CCMs)**
9. **Where do you receive this treatment/care?**

Section C: Challenges pertaining to Prevention of HIV Comorbidities

The questions in this section are aimed at understanding how easy or not it has been for you to prevent the diagnosis of an additional chronic condition after being diagnosed with HIV.

10. **Have you ever received any information regarding the risks and prevention of chronic conditions for persons living with HIV ?**

    If yes, what kind of information did you receive? Where did you receive this information?

    If no, what kind of information would you have liked to receive?

11. **Have you used or done anything to prevent developing the additional chronic condition that you are diagnosed with? Please explain**
12. **In what way, *if any*, can you say that your doctor /or nurse assisted you to prevent the occurrence of your Comorbidity?**
13. **What challenges regarding to the prevention of Non-HIV conditions/diseases do you or have you experienced?**
14. **What advice would you give to someone that is diagnosed with HIV and wants to prevent the developing additional chronic conditions?**
15. **Do you think that it is necessary for HIV positive persons to test for other chronic conditions? Why or Why Not ?**

Section D: Challenges pertaining to Treatment

The questions in this section are aimed at understanding how easy or not it is, or has been, for you to manage and access treatment for HIV comorbidities.

16. **Do you think that you have sufficient knowledge about how to manage both HIV and the additional chronic condition (mention condition stated in B2) that you are diagnosed with? Please describe how you manage these conditions daily.**
17. **What support, if any, do you need in order for you to better manage both HIV and the additional chronic condition (mention condition stated in B2) that you are diagnosed with condition?**
18. **How easy or not is it for you to reach your local health facility (clinic, doctor, pharmacy etc.) ?**
19. **Do you think/feel that your local health facility is adequately equipped to assist and treat persons diagnosed with both HIV and additional chronic conditions? Why do you say so?**
20. **Please describe how being diagnosed with an additional chronic condition has impacted you financially.**
21. **What are some of the challenges/issues/barriers that you face with regards to the management of both HIV and the additional chronic condition (mention condition stated in B2) that you are diagnosed with condition?**
22. **How best, and by whom, do you think that these challenges can be addressed?**

Do you think it is necessary to have education sessions for healthcare providers on caring for persons with comorbidities?

If yes, what information/issues do you think are particularly important for healthcare providers to have a clear understanding regarding care for persons with comorbidities?

Section E: Challenges pertaining to Social Interactions

In this section I will ask you about your social interactions, which is the relationships that you have with your spouse, children, family, community etc.

1. **How has being diagnosed with an HIV Comorbidity affected your care for your children /or any other persons under your care?**
2. **How has being diagnosed with an HIV Comorbidity affected your interaction with your spouse, peers and/or community members ?**
3. **How has being diagnosed with a Comorbidity affected your productivity in the workplace?**
4. **Do you think that your social life has changed in any way since you found out that you are diagnosed with a Comorbidity? If so, how ?**
5. **Is there any stigma or discrimination that is separate from any HIV stigma/discrimination you have experienced from your family, peers or community because you are diagnosed with an additional chronic condition? If yes, please describe.**
6. **What support do you think your family, peers, colleagues, community etc. should provide to assist you to better manage your condition?**

Section F: Challenges pertaining to Disclosure

In this section, I want us to discuss how easy, or not, it has been for you to tell or share your health status with your family, children, employer etc.

1. **Have you disclosed your HIV status to your employer/spouse/family? If not why? If yes, please describe how difficult or easy this process was and the response you received,**
2. **Have you disclosed to your employer/spouse/family that you have an additional chronic condition? If not, why. If yes, please describe how difficult or easy this process was and the response you received.**
3. **What factors do you think hinder people living with HIV and additional chronic conditions to be open about their health status to their employers/spouse/families etc?**
4. **What factors do you think can assist people living with HIV and additional chronic conditions to be more open about their health status to their employers/spouse/families etc?**

Section G: Coping Mechanisms

1. **What factors do you think enable you to cope with living with two chronic conditions (HIV and …….*mention additional chronic condition stated*)**

CONCLUSION

Do you have any recommendations that could assist policy makers to address the challenges faced by persons living with HIV and other chronic conditions in South Africa?

1. **Is there anything else you would like us to know?**
2. **Do you have any specific questions or concerns?**

THANK YOU FOR PARTICIPATING IN THIS INTERVIEW

Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study

Interview Guide for Healthcare providers

Thank you for taking the time to participate in this study. Please note that your participation is completely voluntary, and you can withdraw at any time without consequences.

Objective: To understand the challenges regarding treatment and access to healthcare faced by adults with HIV chronic co-morbidities in South Africa.

SECTION A: Interviewee Information

1. **What is your current role at this health facility (Hospital/Clinic)? Please describe your responsibilities.**

Section B: Prevention and Care of HIV Comorbidities

Research shows that people diagnosed with HIV are at an increased risk of developing additional chronic conditions.

2. **What HIV chronic comorbidities do most of your patients have?**

   Probe: HIV + Hypertension, HIV + Diabetes, HIV + asthma, HIV + Cancer, HIV + Heart disease, HIV + COPD, HIV + stroke

3. **What do you think are some of the main causes/reasons why people develop these HIV chronic comorbidities?**
4. **How do you think persons living with HIV can prevent the development of additional chronic conditions?**
5. **Are there any support structures offered/should be offered by the Hospital/Clinic to assist person living with HIV to prevent other chronic conditions?**

Section C: Treatment of HIV Comorbidities

The treatment and management of chronic disease remains a challenges for both patients and health care providers (HCWs).

6. **What medical treatment do you provide to persons with HIV CCMs?**

   Probe: treatment provided for HIV and additional chronic condition

7. **Besides the medical treatment, how else do you care for persons with HIV CCMs?**
8. **What are some of the challenges that HCWs face regarding providing care for persons living with HIV and additional chronic comorbidities?**
9. **How best do you think we can mitigate the challenges faced face regarding providing care for persons living with HIV and additional chronic comorbidities?**
10. **What are some of the challenges that you think persons living with HIV chronic comorbidities face regarding treatment and management of their conditions?**
11. **How best do you think we can mitigate the challenges faced by persons living with HIV chronic comorbidities in South Africa?**
12. **Would you say that HCWs are adequately capacitated to treat and care for persons with HIV comorbidities?**
13. **What support structures are offered/should be offered to HCWs such that they are better able to assist person living with HIV comorbidities to manage their conditions?**

CONCLUSION

14. **Do you have any recommendations that could assist to mitigate the challenges faced by persons living with HIV chronic comorbidities in South Africa?**
15. **Is there anything else you would like us to know?**
16. **Do you have any specific questions or concerns?**

THANK YOU FOR PARTICIPATING IN THIS INTERVIEW

APPENDIX D: Research Tools – Information Sheets

Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study

Study Information Sheet for In-Depth Interview with adults with HIV Chronic Comorbidities

INTRODUCTION

Provide information below and ensure consents forms are signed and collected.

Hello, my name is *Motlatso Godongwana* I am a PhD student in the Demography & Population Studies Programme at the University of the Witwatersrand.

As part of my studies, I am undertaking a research titled the **"Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study"**

I have asked you to participate in this interview today to discuss and understand some of the challenges you face regarding living with chronic co-morbidities (CCM). CMM refers to the diagnosis of more than one chronic condition within the same individual at the same time. In this study it refers to living with HIV and an additional chronic condition. I would like us to discuss the challenges you face regarding access to prevention and treatment of CCM, social interactions since diagnosis, how easy it has been for you to disclose your CCM status as well as your coping mechanisms.

This research requires your willingness to participate and provide honest feedback. The interview will be completely confidential. There is no right or wrong answers. The interview will last for about 60 minutes. By choosing to participate in this study we do not anticipate any risk of harm to you, however, should you experience distress please feel free to inform the researcher. You can also contact the resources provided at the end of this information sheet.

You will not receive any incentive i.e. rewards, gifts or other compensation for participating in this research. The answers you provide will help me to understand the health needs of adults diagnosed with CCM as well as the barriers for prevention and treatment of CCMs. The findings from this research will be included in my PhD research report which may be used for publication and/or help chronic disease policy makers to better understand the challenges and needs of adults living with CCMs in order to prevent and assist those diagnosed with CCMs in South Africa.

I would like to audio record this interview in order to capture all the information from today. Your answers will be reported anonymously. This means that your name will not be recorded with your answers anywhere in the report.

If you do not understand any of the questions or how to answer them, please ask for me for clarification. If uncomfortable, you can decide not to answer some questions and can leave the interview at any point.

Should you agree to participate in this research after reading this information sheet, please sign the consent form provided to you. There will be no consequences for you if you choose not to participate in this interview.

Voluntary participation

Please note that participation is voluntary, and you have a right to refuse to participate or withdraw at any time during the data collection process. Refusing or withdrawing from the study will not involve any penalty or loss of benefits to you.

How will anonymity and confidentiality be maintained?

The interview is between you and the interviewer. The interview will be conducted in a private space where a third person cannot access or form part of the discussion. You will remain anonymous because your name will not be audio recorded or written anywhere in the final report or on the questionnaire. There will be no way of linking your experiences/opinions/responses to your identity.

To maintain confidentiality, the information we collect from you will not be shown to anyone outside of this research in a way that would identify you. The results of the research will be stored in a computer folder with password authorization accessible to the researcher only.

How will the research be used?

It is anticipated that the research findings will be published in 3-4 journal articles. The results of all interviews conducted will be combined, analyzed and reported on at group level.

Reimbursements

Please note that there will be no payment or cost associated with participating in the study.

What should be done if you experience any psychological distress during the interview?

You may choose to discontinue with the interview at any point should you feel uncomfortable or distressed. In the event that you are psychological distressed and require assistance, you may, or ask the interviewer, to contact the following institutions for assistance:

- **Wits Counselling and Careers Development Unit (CCDU)**
  Tel: 011 717 9140 / 32
  Email: info.ccdu@wits.ac.za
- **Life Line Johannesburg**
  Tel: **011 728 1347/ 011 728 1331**
  Email: lifeline@lifelinejhb.org.za

Revive Counselling Centre – Eastern Cape
- Tel: **041 373 8882/3**

Where can I get information?

If you have questions about this research, you can contact:

- **Motlatso Rampedi – Researcher**
  Tel: +27 **(**0) 71 169 7209
  Email: motlatso.rampedi@gmail.com
- **Dr. Nicole DeWet – Research Supervisor**
  Tel: 011 717 4338
  Email: nicole.dewet@wits.ac.za

If you have questions about your rights as a participant, you can contact:

- The Human Research Ethics Committee (HREC Medical)
  Research Office
  Faculty of Health Sciences
  University of the Witwatersrand
  Phillip Tobias Building
  Parktown
  South Africa
  2193

  Contact person:
  Rhulani Mkansi
  Tel: +27 (0)11 717 2700
  Email: Rhulani.Mkansi@wits.ac.za

Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study

Information Sheet for Key Informant Interview with Healthcare workers

INTRODUCTION

Provide information below and ensure consents forms are signed and collected.

Hello, my name is *Motlatso Godongwana*. I am a PhD student in the school of Demography & Population Studies at the University of the Witwatersrand.

As part of my studies, I am undertaking a research thesis entitled the **"Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study"** I have asked you to participate in this interview today to discuss key health issues in addressing challenges faced by persons with HIV chronic comorbidities (CMMs) in south Africa. CMM refers to the diagnosis of more than one chronic condition within the same individual at the same time. In this study it refers to living with HIV and an additional chronic condition. I would like us to discuss the role of Healthcare providers to assist HIV positive persons to prevent additional chronic conditions, the current treatment and care provided and other issues relating to prevention, treatment and care for HIV comorbidities.

This research requires your willingness to participate and provide honest feedback. The interview will be completely confidential. There is no right or wrong answers. The interview will last for about 30 minutes. By choosing to participate in this study we do not anticipate any risk of harm to you, however, should you experience distress please feel free to inform the researcher. You can also contact the resources provided at the end of this information sheet.

You will not receive any incentive i.e. rewards, gifts or other compensation for participating in this research. The answers you provide will help me to understand the health needs of adults diagnosed with CCM as well as the barriers for prevention and treatment of CCMs. The findings from this research will be included in my PhD research report which may be used for publication and/or help chronic disease policy makers to better understand the challenges and needs of adults living with CCMs in order to prevent and assist those diagnosed with CCMs in South Africa.

I would like to audio record this interview in order to capture all the information from today. Your answers will be reported anonymously. This means that your name will not be recorded with your answers anywhere in the report.

If you do not understand any of the questions or how to answer them, please ask for me for clarification. If uncomfortable, you can decide not to answer some questions and can leave the interview at any point.

Should you agree to participate in this research after reading this information sheet, please sign the consent form provided to you. There will be no consequences for you if you choose not to participate in this interview.

Voluntary participation

Please note that participation is voluntary, and you have a right to refuse to participate or withdraw at any time during the data collection process. Refusing or withdrawing from the study will not involve any penalty or loss of benefits to you.

How will anonymity and confidentiality be maintained?

The interview is between you and the interviewer. The interview will be conducted in a private space where a third person cannot access or form part of the discussion. You will remain anonymous because your name will not be audio recorded or written anywhere in the final report or on the questionnaire. There will be no way of linking your experiences/opinions/responses to your identity.

To maintain confidentiality, the information we collect from you will not be shown to anyone outside of this research in a way that would identify you. The results of the research will be stored in a computer folder with password authorization accessible to the researcher only.

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It is anticipated that the research findings will be published in 3-4 journal articles. The results of all interviews conducted will be combined, analyzed and reported on at group level.

Reimbursements

Please note that there will be no payment or cost associated with participating in the study.

What should be done if you experience any psychological distress during the interview?

You may choose to discontinue with the interview at any point should you feel uncomfortable or distressed. In the event that you are psychological distressed and require assistance, you may, or ask the interviewer, to contact the following institutions for assistance:

- **Wits Counselling and Careers Development Unit (CCDU)**
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  Email: info.ccdu@wits.ac.za
- **Life Line Johannesburg**
  Tel: **011 728 1347/ 011 728 1331**
  Email: lifeline@lifelinejhb.org.za
- Revive Counselling Centre **– Eastern Cape**
  Tel: **041 373 8882/3**

Where can I get information?

If you have questions about this research, you can contact:

- **Motlatso Rampedi**
  Tel: +27 **(**0) 71 169 7209
  Email: motlatso.rampedi@gmail.com
- **Dr. Nicole DeWet – Research Supervisor**
  Tel: 011 717 4338
  Email: nicole.dewet@wits.ac.za

If you have questions about your rights as a participant, you can contact:

- The Human Research Ethics Committee (HREC Medical)
  Research Office
  Faculty of Health Sciences
  University of the Witwatersrand
  Phillip Tobias Building
  Parktown
  South Africa
  2193

  Contact person:
  Rhulani Mkansi
  Tel: +27 (0)11 717 2700
  Email: Rhulani.Mkansi@wits.ac.za

APPENDIX E: Research Tools – Consent Form

Informed Consent Form

Good Day,

My name is **Motlatso Godongwana** and I am doing research on the: "**Dynamics associated with HIV chronic co-morbidities among adults in South Africa: A population-based mixed method study".**

After reading through the information sheet, please go over the points below and indicate with a tick where you approve.

Please sign the consent form once you have read, understood and agree to participate in the research. You are free to ask any question at anytime where you are unclear with any of the statements made.

- I understand that if I choose to participate in this research, I will be asked to share my opinions and experiences regarding living with HIV comorbidities. ☐
- I understand that my participation in this research is voluntary and that I can choose to withdraw from the discussion at any time, without facing any consequences. ☐
- I understand that my identity will be kept anonymous (hidden) and that my name will not be included in the research results. ☐
- I understand that there are no expected benefits or consequences associated with participating in this research. ☐
- I understand that the results of this research will be reported at an overall level – based on all of the participants' answers. ☐
- I understand that the results from this research may be published in 3-4 academic journals. ☐
- I agree to take part in this study. The purpose of the study has been explained to me and I have had a chance to ask questions. ☐

[Participant] I _____ (Name and Surname) have read through the above-mentioned points and agree to participate in the research study.

_____ _____

Participant Signature Date

APPENDIX F: Qualitative Fieldwork Report

UNIVERSITY OF THE
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FIELDWORK REPORT

Dynamics of HIV Chronic Comorbidities among adults in South Africa: A population-based mixed-methods study

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The purpose of this document is to provide an account of the fieldwork conducted for the qualitative data collection for the study titled: **Dynamics of HIV Chronic Comorbidities among adults in South Africa: A population-based mixed-methods study.**

Principal Investigator	Motlatso Godongwana
Period of Data collection	23 March 2020 – 22 May 2020
Sites visited	Gauteng Eastern Cape
Data collection method	Face-to-face interviews Telephonic Interviews

Introduction

A substantial amount of research has shown that people living with HIV (PLWH) are at an increased risk of developing additional chronic conditions, with specific reference to hypertension and diabetes (D. J. Kim et al., 2012; Lalkhen & Mash, 2015). Indeed, research in South Africa has also shown that PLWH are faced with an increased risk of developing chronic diseases such as hypertension and diabetes as compared to the HIV negative population (Chhoun et al., 2017; Rodríguez-Arbolí et al., 2017). Previous studies in South Africa have reported the prevalence of ComorbidityComorbidty comorbidty among HIV infected adults aged 50 years and above to be (29%) (Negin et al., 2012b). At the community level, a study in KwaZulu-Natal found that about 56% of its HIV positive study participants had a chronic Comorbidity (van Heerden et al., 2017). In addition, recent literature shows that, in South Africa, PLWH that are diagnosed with cardio metabolic conditions such as hypertension and diabetes were less likely to progress along the care continuum (Chang et al., 2019a).

Qualitative Research Objective

As part of the third objective of this study, we aimed to understand the challenges regarding treatment and access to healthcare faced by adults (18 - 75 years old) with HIV chronic co-morbidities in South Africa.

Study Population

The population of interest in this study was adults (18- 75 years old) diagnosed with HIV Chronic comorbidities. In addition, Healthcare workers (Doctors and nurses) that provide treatment and/or care to these patients were sampled in order to align the health system challenges to the treatment and access challenges experienced by patients.

Sample Size

The total sample size for this study was 24; comprising x12 KIIs with healthcare providers and x12 IDIs with adults living with HIV Chronic Comorbidities (HIV CCMs). The proposed sample size was obtained and data saturation achieved. However, due to the use of snowballing to obtain the sample of healthcare providers, data collection only occurred at some of the health facilities proposed in the above table. A list of all additional data collection sites, including those initially proposed, is as shown in figure 1 below.

Table F1: List of all healthcare facilities were data collection was successfully conducted

Health Facility	Initially Proposed (Y/N)	No. of Healthcare Providers	Type of HCW	Adult participants
Eastern Cape				
New Haven Chronic Sick Hospital	Y	X1	Professional Nurse	-
Frere Hospital	N	X1	Doctor	-
SS Gida Hospital	N	X1	Doctor	-
Aspiranza Clinic	Y	X1	Professional Nurse	-
Kwelera clinic	Y	X1	Professional Nurse/Hospital Manager	X6
Zanempilo Clinic	Y – Not conducted	-	-	-
Zwide Clinic	N	X1	Professional Nurse	-
Gauteng				
Mary Moodley Clinic	N	X1	Professional nurse	-
Sizwe Tropical Hospital	Y – Not conducted	-	-	-
Zuzimpilo Clinic	Y – Not conducted	-	-	-
Yeoville Clinic	Y	X1	Professional nurse	-
Slovoville Clinic	Y	X2	Professional nurse	X2
Chaiwelo Clinic	Y	X1	Professional nurse	X1
Duduza Clinic	N	X1	Professional nurse	
Nokuphila Clinic	Y	-	-	X3
Total		**12**		**12**

Data Collection

As shown in the conceptual framework presented in figure 2, the data collection was conducted to gain insight on challenges pertaining to access to treatment, prevention of HIV CCMs as well overall self-management of HIV CCM diagnosis. Adults participants who met the study criteria and with differing demographic and socio-economic characteristics were recruited for this study. These participants were also requested to provide a self-reported history of their chronic risk behaviours.

Recruitment Process

The qualitative sample in both the EC and Gauteng was selected using hospital and clinic records. Using purposive sampling, the researcher firstly developed a list of hospitals and clinics in each province that provide HIV and Chronic treatment (*table 1*). Face-to-face and

telephonic appointments with hospital or clinic managers of the selected health facilities were arranged. However, interviews were successfully conducted with healthcare workers and adults from some of these facilities.

Gauteng

In Gauteng, the researcher held face-to-face meetings with two clinic managers to explain the study purpose and objectives. After explaining the study objectives and providing the necessary permission and clearance letters, the managers facilitated an introduction to the healthcare workers that provide treatment and care to persons living with HIV and other Chronic conditions. However, x2 face-to-face Key Informant Interviews (KIIs) were conducted with only two professional nurses from one of the sampled clinics (Slovoville clinic, Soweto). Two of the healthcare workers at the second clinic provided a future date to conduct the KIIs. However, using the clinic records, these healthcare providers recruited the sample of adults (18-75 years old) living with HIV and additional chronic conditions (Hypertension, diabetes, stroke, cardiovascular diseases, and cancer) and receiving their primary chronic care from the clinic. In line with literature that has been conducted in this field, the healthcare workers mentioned that Hypertension and Diabetes were the most common additional chronic condition among PLWH. As a result, the HIV positive participants that were recruited either had Hypertension or Diabetes. In total x7 face-to-face interviews were conducted; x2 KIIs and x5 In-depth Interviews with adult participants.

Challenges

On March 27, 2020, data collection in Gauteng was interrupted by South Africa's announcement of the nationwide lockdown because of the Covid-19 pandemic. Some of the lockdown regulations restricted travel and movement of persons including enforcing stringent social distancing measures. All this was occurring, unfortunately, during the period scheduled for the remaining KIIs with healthcare workers and In-depth Interviews (IDIs) with adults. These regulations prohibited face-to-face contact. The researcher made attempts to telephonically contact the managers of the remaining hospital and clinic (*marked Y-Not conducted in figure 1*). However, most mentioned that their health facilities were under a lot of pressure given the rise of the Covid-19 pandemic and that many of their staff were, in addition to providing health services, preoccupied with Covid-19 training and capacity building.

Mitigation Strategy

In an effort to remain within the study timelines, the snowballing sampling technique was employed to allow the recruited sample of healthcare workers to recruit other healthcare professionals that met the study criteria (i.e. involved in treatment and care of HIV and Chronic patients). The snowballing method is useful for hard to reach population (Bonevski et al., 2014). Following this method, telephonic KIIs were conducted with the remaining x5 healthcare providers. However, this meant that the recruited sample of healthcare workers were from different health facilities, as shown with the additional list of health facilities presented in figure 2 above.

Eastern Cape

In the Eastern Cape, hospital and clinic managers were all contacted telephonically. Where successfully reached, the managers requested that the study materials (ethical clearance, permission letters and information sheets) be shared by email or WhatsApp. Some clinic managers preferred WhatsApp because of network connectivity challenges which limited access to emails, particularly in the rural areas. The clinic managers provided the researcher with the contact details of the healthcare providers that met the study criteria. Of the health facilities that were initially proposed, telephonic KIIs were successfully conducted with x2 professional nurses at two of the clinics. Namely Aspiranza clinic (urban) and Kwelera clinic (rural). Using the clinic records, the Healthcare worker at Kwelera clinic (also serving as a hospital manager) recruited a sample of x6 adults (18-75 years old) that met the study criteria. Again, the recruited adult participants either had Hypertension or Diabetes.

Challenges

The researcher initially proposed to conduct face-to-face KIIs and IDIs in the Eastern Cape. However, as caution to the rising Covid-19 pandemic, fieldwork in the Eastern Cape scheduled from March 18 to 06 April 2020 was postponed. Following cancellation after enforcement of the nationwide lockdown regulations that further prohibited interprovincial travel. In addition, the researcher intended to recruit x6 healthcare workers from the list of health facilities in *table 1* and x6 adult participants from rural and urban Eastern Cape. After making attempts to contact some of the health facilities telephonically, again some mentioned that their health facilities were under a lot of pressure given the rise of the Covid-19 pandemic. In addition, the Healthcare worker at Aspiranza clinic (urban) was unsuccessful in her attempt to recruit adult participants, mentioning that she lacked staff capacity to assist her with the recruitment. While the Healthcare worker at Kwelera clinic managed to recruit the total intended sample of x6 adult participants, the clinic is located in a rural areas and the results might show a rural bias, at least in the Eastern Cape.

Mitigation Strategy

Given the inability to travel to the Eastern Cape, telephonic interviews were conducted will all healthcare providers and adult participants in the Eastern Cape. Similar to Gauteng, the snowballing sampling technique was employed to allow the recruited sample of healthcare workers to recruit other healthcare professionals that met the study criteria (i.e. involved in treatment and care of HIV and Chronic patients). This again resulting in healthcare providers that were from different health facilities (*figure 2*). The snowballing approach was used after some of the contacted facility managers mentioned that the period of the proposed research was unfavourable given the rising pandemic. Following this method, an additional x4 telephonic KIIs were conducted with healthcare providers. To mitigate the possible rural bias in the adult findings from the Eastern Cape, the researcher over sampled the urban participants in Gauteng, as Gauteng is predominately made up of urban and peri-urban settings.

Ethical Considerations

All study participants were provided with a study information sheet prior to commencing the study. For the face-to-face interviews, participants were required to sign the study consent form. The information sheets for the telephonic interviews were read out at the beginning of each interview and consent was obtained verbally. Where verbal consent was provided, the names, contact details and date of interview were hand written on the study consent forms.

Both face-to-face and telephonic interviews were recorded. These recordings have been stored in a password accessible computer which only the researcher has access to.

Some of the adult participant interviews were conducted in the local language, isiXhosa. These recordings were transcribed back to English a language student from the University of Fore Hare. All other transcription was conducted by two research assistants based at the Respiratory and Meningeal Pathogens Research Unit of the University of the Witwatersrand.

The inclusion of telephonic interviews was not initially included in the research protocol accepted by the Human Research Ethical Council (M190683). An application to amend the protocol to include telephonic interviews given the COvid-19 pandemic was sent to HREC on 05 June 2020. The researcher is still awaiting the outcome of this application.