Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use all or part of this thesis or dissertation in future works (such as articles or books).

Signature:

_____ _____

Aly Drame Date

Risk factors for non-communicable diseases in HIV-infected people at the Donka National Hospital in Conakry, Guinea

By

Aly Drame

Master of Public Health

Executive MPH (Applied Epidemiology)

_____

Jeb Jones

Committee Chair

_____

Cissé Mohamed

Field Advisor

Risk factors for non-communicable diseases in HIV-infected people at the Donka National Hospital in Conakry, Guinea

By

Aly Drame

MD (Doctor of Medicine) Kofi Annan University of Guinea, 2016

Thesis Committee Chair: Jeb Jones, Ph.D., MPH, MS

Field Advisor: Cissé Mohamed, Full Professor of Dermatology-venereology, MD

An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology

2022

Abstract

Risk factors of non-communicable diseases in HIV-infected people at the Donka National Hospital in Conakry, Guinea

By Aly Drame

Objectives: To understand risk factors for Hypertension, type II diabetes mellitus, and Cancer among patients with HIV at Donka national hospital in Guinea.

Design: This study was a retrospective cohort study design.

Methods: This study used clinical data from HIV-infected people diagnosed, hospitalized, or receiving HIV treatment at the Donka National Hospital from June 2021 to December 2021.
Data from medical charts were entered into a computer and cleaned using Excel and SAS. Descriptive statistics for dependent and independent variables were calculated. The distribution of non-communicable diseases according to all the covariates was determined. The continuous variables (age, BMI, time on ART treatment, and viral load) were categorized. The overall prevalence of the three outcome diseases and the prevalence of each of them was estimated; Separate regression models (SAS Sudaan with proc rlogist) were calculated for each of the three outcomes: Hypertension, Diabetes, and Cancer. For each disease outcome, unadjusted and adjusted prevalence ratios were estimated to assess the risk factors of having that outcome in HIV-infected people.

Results: Of 1087 baseline patients enrolled in this study, 901 had complete data and were included in analyses. Overall, the patients were evenly divided between males (52.6%) and females (47.4%), and non-communicable diseases were present in 634 people (70.3%).

Among the study participants, about one-third (31.3%) had been on ART treatment for less than 2 years, 28.1% for a time between 2 and 4 years, and 40.6% for more than 4 years. Most participants were between 18 and 35 years old (63.7%) and had a normal BMI (61.5%). Type 1 HIV represented 99.0% of the cases, 97.1% of the study participants were on regular ART treatment, and 32.4% were alcohol consumers. There were 331 (36.7%) cases of Hypertension, 315 (35.0%) cases of Diabetes, and 195 (21.4%) cases of Cancer.

The adjusted prevalence ratio (PR) of Hypertension in alcohol consumers compared to non-alcohol consumers was 1.4 (95% CI: 1.2, 1.7), and the adjusted prevalence ratio of Diabetes in non-alcohol consumers compared to regular alcohol consumers was 2.0 (95% CI: 1.7, 2.4), and finally, the prevalence ratio of Cancer in alcohol consumers compared to non-alcohol consumers was 0.8 (95% CI: 0.5, 0.9).

Conclusion: We identified several factors associated with prevalent Hypertension, Cancer, and Diabetes among patients living with HIV. One limitation of this analysis is that all patients had at least one non-communicable disease; therefore, we did not have a control group of patients with HIV who did not have a non-communicable disease. This study's results might help identify patients with HIV at high risk of developing non-communicable diseases.

Risk factors for non-communicable diseases in HIV-infected people at the Donka National Hospital in Conakry, Guinea

By

Aly Drame

MD (Doctor of Medicine) Kofi Annan University of Guinea, 2016

Thesis Committee Chair: Jeb Jones, Ph.D., MPH, MS

Field Advisor: Cissé Mohamed, Full Professor of Dermatology-venereology, MD

An abstract of

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology

2022

Acknowledgements

I sincerely thank my thesis committee members, Jeb Jones, and Cissé Mohamed, for their guidance, support, and patience through this process. They were both extremely patient, knowledgeable, kind, and helpful. They offered me invaluable insight and expertise, thus making this process a unique learning experience.

CHAPTER I: *INTRODUCTION*

A non-communicable disease (NCD) is a chronic health condition that does not result from infection and is not transmissible. It is also defined as a disease with a prolonged course that might not resolve spontaneously and for which a total cure is rarely achieved [1]. Since the third epidemiological transition (substantial decrease in morbidity and mortality from infectious diseases, contrasting with the predominance of chronic and metabolic diseases as the leading causes of morbidity and mortality), non-communicable diseases have been the primary causes of death globally, resulting in 41 million deaths each year, representing 71% of all deaths (Bigna & Noubiap, 2019). The four deadliest non-communicable diseases are cardiovascular diseases (17.9 million), cancers (9 million), respiratory diseases (3.9 million), and Diabetes (1.6 million) (Bigna & Noubiap, 2019). These four groups of diseases represent nearly 80% of all premature deaths due to non-communicable diseases [2]. The prevalence of these diseases is increasing in developing countries where infectious diseases remain significant public health challenges (Getahun et al., 2020).

According to the World Health Organization (WHO), the number of deaths due to non-communicable diseases is expected to grow by 17% in the next ten years globally [2], and 77% of deaths associated with non-communicable diseases will occur in low and middle-income countries [2]. This rapid increase is due to poor urbanization, the rapidly growing population [3], and poor diet habits (Casari et al., 2022). In sub-Saharan Africa, non-communicable diseases are projected to overtake infectious diseases as significant causes of morbidity and mortality by 2030 (Mudie et al., 2019), as the average income in many African countries is projected to increase, thus becoming a significant health concern. Growing revenues are correlated to a decrease in the prevalence of

communicable (infectious) diseases and an increase in mortality from non-communicable diseases such as Diabetes, cancers, and heart disease [4].

Human immunodeficiency virus (HIV) causes severe reductions in immune system functioning due to the destruction of the T-helper cells, which are responsible for immune system activation. HIV infection will thus expose the infected person to a greater risk of morbidity and mortality from any other infectious disease. There is no complete cure for HIV infection, and it is most prevalent in sub-Saharan Africa, home to more than 70% of people living with HIV globally (Kharsany & Karim, 2016). Sub-Saharan Africa also accounts for 75% of HIV deaths and 65% of new HIV infections worldwide (Dwyer-Lindgren et al., 2019), despite tremendous efforts and resources that local governments and international partners have allocated to reduce its burden. With the advent and the availability of antiretroviral therapy (ART), HIV management has evolved from acute emergency responses to long-term disease management that must be handled in a broader context, including other chronic health conditions [3]. Compared to the general population, the rates of non-communicable diseases are high in people with HIV who are on adequate HIV treatment [3]. Thanks to increased accessibility of highly effective ART, HIV-infected people now live longer (similar to the rest of the population) despite non-HIV-related chronic conditions [3]. This is due to the combination of the increasing lifespan of HIV-infected people resulting in the accumulation of the effects of HIV and other factors including impacts of antiretroviral therapies, the traditional risk factors of non-communicable diseases such as smoking tobacco, alcohol use, lack of physical activity, poor diet, and the demographic and epidemiologic transitions (Kansiime et al., 2019).

The co-occurrence of non-communicable diseases (NCD) and HIV in sub-Saharan Africa, where infectious diseases are already major health threats, presents growing concerns (van Heerden et

al., 2017). The comorbidities, however, result in more complex disease patterns. Those patterns can have additive or multiplicative effects on the overall health outcomes (Getahun et al., 2020). The comorbidity of HIV and NCD makes patient management more complex, often leading to poorer health outcomes and increasing healthcare costs for patients with multiple comorbidities (van Heerden et al., 2017). It also represents a substantial economic and health threat to households, especially in sub-Saharan Africa, where most people are poor with limited resources, while healthcare costs are increasing(van Heerden et al., 2017).

Evidence about the prevalence of risk factors of non-communicable diseases in West Africa is minimal. In Guinea, the prevalence of HIV is 1.7%, representing an estimated 120,000 people living with HIV [5], and according to the world bank, non-communicable diseases in 2019 represented 33.3% of all causes of death [6]. The most prevalent NCD in 2015 were Diabetes (5% of prevalence in subjects aged 15 to 64), chronic respiratory diseases (12.4% prevalence), high blood pressure (28.1% prevalence), and cancers (0.247% people) [6]. However, the effects of the association between HIV infection and non-communicable diseases in Guinea are still unknown. This study aims to determine the prevalence of identified risk factors for diabetes mellitus, high blood pressure, and Cancer in people living with HIV at the Donka National Hospital in Guinea. Data from this study will help better understand and address the issue representing the burden of HIV/NCD in Guinea.

We hypothesize that the prevalence of NCDs in HIV-infected people at Donka will follow the overall trends as in the previous studies. We also hypothesize that the trends of NCDs in HIV-infected people depend on patients' age, lifestyle, excess weight, and the duration of ART treatment.

CHAPTER II: *Background & Review of the Literature*

Since the beginning of the HIV pandemic, studies have shown that HIV infection increases the risk of developing non-communicable diseases (Ciccacci et al., 2019). Studies have also established that HIV-infected people in sub-Saharan Africa are experiencing growing comorbidities, mainly due to increased life expectancy and long-time antiretroviral (ART) treatment (Ciccacci et al., 2019). A hospital-based study of HIV patients on ART in Zimbabwe found that the most prevalent non-communicable diseases were Hypertension (HTA), cardiovascular diseases, diabetes mellitus, and cancers (Cheza et al., 2021)**.** The rising number of patients with HIV and acquired immunodeficiency syndrome (AIDS) is partly due to improved screening, earlier diagnosis, comprehensive treatment methods, and better accessibility to and acceptance of therapy. Improved methods of detection of HIV, earlier diagnosis, and better management have helped improve the survival of these patients.

There is strong evidence for an association between HIV and the prevalence of non-communicable diseases, mostly in low-income countries. The findings showed that Cancer, Hypertension, and Diabetes occur with varying frequency among HIV-infected people. The most plausible explanation for that lies in the action of HIV infection on the human body (renal and blood vessel damage in Hypertension, the destruction of human defense cells due to severe immunodepression in cancers, and protein inhibitions in Diabetes). Another reason might be the prolonged exposure to antiretrovirals (lipodystrophy in Hypertension). Finally, other factors such as precancerous lesions and age, BMI, and physical inactivity increase the chances of getting non-communicable diseases in areas with a high prevalence of HIV. Thanks to the more comprehensive care offered to people with HIV, non-communicable diseases can be efficiently managed along with HIV infection.

While these studies have contributed to our cumulative knowledge about the nexus between HIV and non-communicable diseases, no such research has been undertaken in Guinea, to the best of my knowledge. As a result, this study aims to determine the prevalence and the risk factors for diabetes mellitus, high blood pressure, and Diabetes in people living with HIV at the Donka National Hospital in Guinea. We will provide some of the first estimates of non-communicable disease prevalence among a clinical population of people living with HIV in Guinea and examine risk factors for each disease.

The extant literature on the prevalence of those non-communicable diseases among HIV-infected people is vast. Consequently, the present review limits itself to highly salient and specifically relevant articles on the subject. This review will briefly describe the relationship between HIV and these non-communicable diseases, explaining their prevalence and potential risk factors among HIV-infected people. Then it will analyze some relevant publications on the topic that fit the study context the most.

a- HIV and Hypertension

Unlike the direct and positive correlations between the prevalence of cancers and HIV-related disease, scholars have no conclusive evidence about the relationship between HIV infection and the prevalence of HTA. The most common conditions to increase the risk of HTA are chronic kidney diseases, cardiovascular diseases (specifically blood vessel damage), long-term exposure to ARTs, and chronic inflammation. However, HIV is not the primary cause of non-communicable diseases; many other physiological disorders can cause them. However, the severity of a non-communicable disease can impact the prognosis for HIV-infected people. When a non-communicable disease is severe, it exacerbates patients' health outcomes.

Conversely, when the HTA burden is negligible, HTA ceases to be a life-threatening factor. In many cases, there is HIV infection-induced low blood pressure. The most plausible explanation lies in cardiovascular autonomic dysfunction leading to low blood pressure levels in HIV-infected people irrespective of the level of immunosuppression (Okello et al., 2017). Another reason is that HIV-infected people in many low-income countries tend to be at an advanced HIV stage when entering HIV care and might have comorbid opportunistic infections that can lower their blood pressure levels directly or through weight loss (Okello et al., 2017). Better control of Hypertension, more comprehensive HIV care and lower level of hypertension risk behavior among people living with HIV might reduce the hypertension burden in HIV-infected people (Davis et al., 2021).

High prevalence of Hypertension has been found in primary research and meta-analyses among HIV-infected people. The highest prevalence of Hypertension was found in a study of non-communicable diseases in HIV-infected people in Brazil, which found similar prevalences of Hypertension across the lifespan among people living with HIV (17% among those <50 years old, 18% among those 50 years and older) (Belaunzaran-Zamudio et al., 2020). They pointed out that the effects of the ARTs commonly prescribed to treat HIV infection (efavirenz- and lopinavir-based regimens with zidovudine and lamivudine) were the leading cause of Hypertension due to dyslipidemia, a common complication of previous first-line ART medicines (Belaunzaran-Zamudio et al., 2020). In a study of prevalence and risk factors of Hypertension and hyperlipidemia in Cambodia, the prevalence of Hypertension was 15.1%, and that of hyperlipidemia was 34.7%. Yet, they did not measure cholesterol levels and did not find a significant association between BMI, age, and non-communicable diseases in HIV- infected people (Chhoun et al., 2017). However, low physical exercise appeared to be associated with a lower risk of non-communicable diseases than moderate or high physical activity levels (Chhoun

et al., 2017). Although they were not able to understand the reasons, they thought the BMIs of people in their study were roughly similar to those of the general population in Cambodia and that people who engaged more in physical exercise were those diagnosed with non-communicable diseases and were told by their primary physician to lower their physical activity (Chhoun et al., 2017).

Different studies conducted in two countries led to varying results concerning the association of HIV and Hypertension in sub-Saharan Africa. In Zimbabwe (Southern Africa), 8.9% of HIV-infected patients were found to have Hypertension, and female gender, ART time on treatment longer than 5 years, and older age (>60-year-old) were risk factors for Hypertension (Cheza et al., 2021)**.** Differences in lifestyle (processed food consumption, sedentary lifestyle) depending on geographical location were significant risk factors for Hypertension. Patients in urban areas were more likely to develop Hypertension due to more access to processed food than peri-urban patients with healthier lifestyles**.** Another study reported a prevalence of Hypertension of 23.9% among HIV-infected people in rural Uganda, with age and BMI significantly associated with Hypertension (Niwaha et al., 2021)**.** This was similar to the prevalence of Hypertension of 21.1% among HIV-infected people identified in a systematic review. However, it is much lower than the HIV-negative population in which the study was conducted (33.5% prevalence) (Patel et al., 2018), indicating that HIV might be protective against Hypertension. The plausible explanation might be the extensive care people with HIV receive along with their current HIV treatment. Unlike the general population, regular healthcare provider visits allow them to be screened and receive appropriate treatment.

b- HIV and Diabetes

Diabetes mellitus or Diabetes is a chronic disease that develops when the blood sugar level (i.e., glucose) is too high. According to their occurring mechanism, there are two types of Diabetes (type 1 and type 2). Type 2 diabetes is the most common type in the general population and people living with HIV. However, some HIV-infected people have recently reported incidents of Diabetes (type of immune restoration syndrome during ART treatment) (Lane & Moin, 2020).

There are two subgroups of patients with Diabetes in the context of HIV: Patients with preexisting Diabetes diagnosed before or at the same time as HIV infection and those who develop Diabetes after the start of therapy (the focus of this study). Each of these subgroups requires a different type of management, as their metabolic dysregulation mechanisms vary. Insulin resistance, rather than insulin deficiency, is usually implicated in the pathogenesis of type 2 diabetes in patients with HIV. Some HIV protein inhibitors directly interfere with type 1 cellular acid-binding protein. This specific protein can interact with and inhibit the peroxisomal proliferator-activated receptor. Once inhibited, the peroxisomal proliferator-activated receptor can lead to insulin resistance and release some fatty acids that highly contribute to insulin resistance (Duguma et al., 2020)**.** However, the major contributor to hyperglycemia in HIV settings is iatrogenic. ART treatment leads to an increase in metabolic dysfunction, including lipodystrophy syndrome. This can result in visceral and central obesity, causing Diabetes (Duguma et al., 2020).

Various endocrine abnormalities are also associated with HIV infection, including growth hormone deficiency and growth hormone resistance. Growth hormone deficiency may contribute

to insulin resistance in HIV-infected people (Kalra et al., 2011). The increasing visceral fat accumulation, with wasting subcutaneous fat noted in patients with HIV, leads to higher levels of inflammatory cytokines such as TNFα, which can cause Diabetes or impaired glucose tolerance by increasing insulin resistance (Kalra et al., 2011).

Several viral factors contribute to diabetes risk. Among those, there is an increased HIV viral load of at least 0.5 logs over six months compared to its initial value at the beginning of those 6 months, a low number of CD4 cells (<200/mm3), and a duration of HIV infection (Kalra et al., 2011).

Duguma et al. (2020), in their study on diabetes mellitus and associated risk factors among adult HIV-infected people on highly active ART, found a prevalence of 11.4% of Diabetes mellitus in HIV- infected people that were not previously known as diabetic (Duguma et al., 2020)**.** Another risk factor for Diabetes was assessed in this study: impaired fasting glucose level or pre-diabetics was identified in 16.6% of people, indicating a high-risk factor for type 2 diabetes mellitus. They concluded that hypertension, BMI, high cholesterol, and ART treatment > 6 years were significantly associated with Diabetes in HIV-infected people (Duguma et al., 2020)**.**

A study conducted in Cambodia (Chhoun et al., 2017) found a prevalence of 8.8% of Diabetes mellitus in HIV-infected people compared to 2.9% in the rest of the population (Belaunzaran-Zamudio et al., 2020)**.** This finding is in accordance with many other studies that concluded that the rate of Diabetes in HIV-infected people is about three to four times higher than that of the general population (Duguma et al., 2020)**.**

However, a systematic literature review of six thousand one hundred and forty-three abstracts found a wide range of diabetes incidence (ranging from 1 to 18%). However, they did not specify which type of Diabetes was diagnosed. This considerable variation across different populations

might be due to a lack of standardized criteria to assess Diabetes. Diabetes alone is an essential factor in cardiovascular diseases (Patel et al., 2018). In that review, many factors were associated with Diabetes in HIV-infected people, including higher age, family history of Diabetes, high BMI, and physical inactivity. However, people with HIV are exposed to inflammation, which directly and indirectly affects insulin mediator hormones (Duguma et al., 2020)**.**

c- HIV and Cancers

Of the three non-communicable diseases examined in this study, the prevalence and risk factors of cancers among HIV-infected people have the most substantial evidence due to their higher prevalence than the other diseases. Because of the severe immunodepression caused by HIV, HIV infection increases the risk of developing many types of cancers. Those types of Cancer include those directly linked to HIV infection itself (Kaposi sarcoma, a variety of skin cancer without metastasis, non-Hodgkin lymphoma, and cervical Cancer) (Hernandez-Ramirez et al., 2017) and those indirectly related to HIV infection (Cancer of the anus, oropharynx cancer, lung cancer, Hodgkin lymphoma) (Wang et al., 2014) & (Coghill et al., 2015)

It has been established that HIV infection increases the likelihood of developing these cancers, the most prominent being Kaposi Sarcoma (Hernandez-Ramirez et al., 2017). Kaposi Sarcoma is a malignant epithelial tumor without any metastasis. It is at the limit of the basic definitions of a benign tumor (abnormal lump or growth of cells at one location without metastasis) and a malignant tumor (abnormal lump or growth of cells that can spread on many body locations and have metastasis). For that ambiguity, some people consider it Cancer leading to the name Kaposi Sarcoma and others consider it a non-cancerous disease, referring to it as Kaposi Disease. This study will call it Kaposi Sarcoma because of its histological nature. Kaposi sarcoma’s appearance rate, including in older people, is higher among those who are living with HIV compared to those

who are not (Hernandez-Ramirez et al., 2017). Four clinical forms of Kaposi Sarcoma have been described.

Four clinical forms of Kaposi Sarcoma have been described.

1. Classic form described in elderly males of Mediterranean and Eastern European most predominant on the lower extremities

2. Endemic form described in Africans, including children, characterized by lymph node involvement

3. Epidemic form described in HIV-infected people, with involvement of the skin and some internal organs

4. Iatrogenic form described in immunosuppressed patients with the same characteristics as in the epidemic form (Bishop & Lynch, 2022).

From a treatment perspective, since the 1990s and the introduction of ART treatment, people on ART drugs experience a lower rate of certain types of Cancer (Kaposi sarcoma and non-Hodgkin lymphoma) than those not on ART (Hernandez-Ramirez et al., 2017). The plausible explanation lies in the direct effects of ART, mainly in reducing viral load. However, since those drugs do not totally eliminate the viruses from the body, the risk of Cancer still persists (Hernandez-Ramirez et al., 2017)**.**

HIV infection is also associated with a substantially increased risk of many other cancers. For instance, HIV infection increases the likelihood of developing anal Cancer, non-Hodgkin and Hodgkin lymphoma, liver cancer, cervical Cancer, oro-pharynx Cancer, and lung cancer

(Hernandez-Ramirez et al., 2017)**.** Besides being linked to an increased risk of Cancer, HIV infection is also associated with a high risk of dying from any type of Cancer. People with HIV infection affected by a type and degree of Cancer are more likely to die of their Cancer than those without HIV presenting the same type and degree of Cancer (Coghill et al., 2015)

Three landmark studies found a strong connection between Cancer and HIV-related diseases. The prevalence of Cancer in patients on ART in Zimbabwe was 1.9% for all types of cancers for both sexes (Cheza et al., 2021). Similarly, a retrospective longitudinal study in HIV- infected people in Kenya found a prevalence of 1.1% of all Cancer combined. (Achwoka et al., 2020) There was no statistical difference between patients on ART and those not on ART (p=0.28), thanks to the early detection of precancerous lesions in some cases, such as cervical Cancer (Achwoka et al., 2020)**.** Like the previous two studies, a meta-analysis found a prevalence of 1.3 and 1.7% of cervical Cancer (Patel et al., 2018). The leading risk factor for having cervical Cancer was the presence of precancerous lesions, which was the case in between 10 to 40% of women in their study (Patel et al., 2018). The variations in the frequency of those precancerous lesions depended on many factors, including the population in which the study was conducted, the patients' age, the stage of immune system deficiency, the technique used to detect precancerous lesions as well, and the method to detect cervical Cancer itself (Davis et al., 2021)**.**

CHAPTER III: *Methodology*

a- Study Environment and Population

This study used clinical data from HIV-infected people diagnosed, hospitalized, or receiving HIV treatment at the Donka National Hospital. Within Donka National Hospital, the services of infectious diseases, dermatology-venereology, and Day Hospital (a unit that only takes care of people with HIV) receive the highest number of HIV cases in Guinea and contributed patient data to this study. Most HIV-infected patients at Donka National Hospital were either referred by other hospitals for HIV complications or diagnosed with HIV in other services within the same hospital and referred to them for better care (e.g., medical and psychological support).

b- Data Extraction Procedures

This study followed a retrospective cohort design with a data collection period of six months, from June 2021 to December 2021. The target population included HIV patients with non-communicable diseases seeking treatment at the Donka National Hospital in Guinea. The hospital was able to de-identify and provide data for 1087 individuals for this study.

- **Inclusion criteria**

People included in this study were those with any biological proof of HIV infection either by HIV rapid test and confirmed with a laboratory test (ELISA, Western Blot, PCR), or by a lab test (HIV and typing), and receiving HIV comprehensive care at the Donka National Hospital

- **Exclusion criteria**

Patients were excluded from this study if they did not have HIV; their medical record was missing primary socio-demographic data (age, sex, weight, BMI, smoking status) or ART intake and treatment time. Patients were also excluded if their primary HIV treatment facility was another

facility other than Donka National Hospital or had been diagnosed with Hypertension, Diabetes, or Cancer before or contemporary to the diagnosis of HIV.

c- Outcomes variables

History of Hypertension, Diabetes, and cancer diagnosis was extracted from the patients' medical records.

A patient was considered to have Hypertension if their systolic blood pressure at complete rest was greater than 139 mmHg and diastolic blood pressure greater than 89 mmHg.

A patient was considered to have type 2 diabetes mellitus if their blood sugar had an HbA1c level ≥ 6.5%. Type 2 diabetes mellitus was also positive when measured blood glucose during fasting ≥ 7.0 mmol/l or blood glucose measured 2 hours after 75 g oral glucose intake ≥ 11.1 mmol/l or a patient displaying symptoms of hyperglycemia with a blood sugar ≥ 11.1 mmol/l.

A patient was considered to have Cancer if they had histological proof of malignant cell proliferation at any body part.

d- Other covariates

Other covariates of interest were age, sex, profession, residency area, weight, BMI, alcohol use, smoking status, ART treatment, ART treatment time, TB treatment, CD4 or viral load count, and HIV type.

e- Ethical considerations

After reviewing and approving the protocol and the written consent forms, the ethical review committee of our host organization and the Emory institutional review board determined that this study is a secondary data analysis of de-identified data; therefore, ethics approval is not required.

CHAPTER VI: *Data Analysis*

All recorded data were rechecked for consistency and completeness. Data were entered into a computer and cleaned using Excel and SAS. Descriptive statistics for dependent and independent variables were calculated. The distribution of non-communicable diseases according to all the covariates was determined. The continuous variables (age, BMI, time on ART treatment, and viral load) were categorized. The overall prevalence of the three outcome diseases and the prevalence of each of them were estimated; Separate logistic regression models with predicted margins standardization were used to estimate prevalence ratios for each of the three outcomes: Hypertension, Diabetes, and Cancer. For each disease outcome, unadjusted and adjusted prevalence ratios were calculated to assess the risk factors of having that outcome in HIV-infected people.

CHAPTER V: *Results*

- **Demographics**

Of 1087 baseline patients enrolled in this study, 901 had complete data and were included in analyses. Overall, the patients were evenly divided between males (52.6%) and females (47.4%), and non-communicable diseases were present in 634 people (70.3%).

Among the study participants, about one-third (31.3%) had been on ART treatment for less than 2 years, 28.1% for a time between 2 and 4 years, and 40.6% for more than 4 years. Most participants were between 18 and 35 years old (63.7%) and had a normal BMI (61.5%). Type 1 HIV represented 99.0% of the cases, 97.1% of the study participants were on regular ART treatment, and 32.4% were alcohol consumers.

In table 2, the socio-demographic variables are stratified by the outcome variables. There were 324 (39.4%) cases of Hypertension, 315 (37.4%) cases of Diabetes, and 195 (23.19%) cases of Cancer.

Among people diagnosed with type 2 diabetes, 56.2% had a job requiring regular physical activity, 69.5% lived in urban areas, and 98.5 % were on ART treatment. Also, among people diagnosed with type 2 diabetes, 36.8 % had been on ART treatment for less than two years, 61.9% had a normal BMI, and 51.4% had a viral load between 75 and 200 copies/ml.

Among patients diagnosed with Cancer, 61.2% practiced regular physical activities at work, and 76.2% were regular alcohol consumers. Among those with Cancer, 98% of Cancer were on regular ART treatment, and 63.2% had normal BMI. However, only 28.5% of cancer cases were smokers, 47.1% were less than 35 years old, and smoking was more prevalent among those with Cancer (28.5 %) compared to Hypertension (6.7%) and Diabetes (17.4%).

- **Hypertension**

Adjusted and unadjusted prevalence ratios of covariates for Hypertension are presented in Table 3. The adjusted prevalence ratio (PR) of Hypertension in alcohol consumers compared to non-alcohol consumers was 1.4 (95% CI: 1.2, 1.7).

The prevalence of hypertension was 20 % higher among those with viral loads between 75-200 copies/ml compared to those with viral loads ≤ 75 copies/ml (PR = 1.2, 95% CI: 0.9, 1.4). The prevalence of hypertension was also 20 % higher among those with viral loads > 200 copies/mL compared to those with viral loads ≤ 75 copies/mL (PR = 1.2, 95% CI: 0.9, 1.6).

Table 3 also shows prevalence ratios for Hypertension in those > 35 to 45 years old compared to those less than 35 years old was 1.7 (95% CI: 1.4, 2.1), and the prevalence ratio for Hypertension in those > 45 to 55 years old compared to those less than 35 years old was 1.7 (95% CI 1.3, 2.2).

Hypertension was less prevalent among underweight people than those with a normal BMI. Underweight people had 30% lower prevalence of hypertension compared to those with normal BMI (PR = 0.7, 95% CI: 0.5, 0.9). However, people with BMI between 25 and 30 kg/m2 had a 30% higher prevalence of Hypertension than those with a normal BMI (PR = 1.3, 95% CI: 1.1, 1.7).

Finally, those with ART treatment time between 2 and 4 years had a 20% lower risk for Hypertension compared to those with ART treatment time less or equal to 2 years (PR = 0.8, 95% CI: 0.7, 1.0), and those with ART treatment time greater than 4 years also had 20% lower risk of Hypertension compared to those with ART treatment time less or equal 2 years (PR = 0.8, 95% CI: 0.6, 0.9).

- **Diabetes**

Adjusted and unadjusted prevalence ratios of covariates for Diabetes are presented in Table 4.

The adjusted prevalence ratio of Diabetes in non-alcohol consumers compared to regular alcohol consumers was 2.0 (95% CI: 1.7, 2.4). The prevalence of Diabetes in those with viral load levels between 75 and 200 copies/ml was 40% higher compared to those with viral load lower than 75 copies/ml (PR = 1.4, 95 % CI: 1.1, 1.7), and the prevalence of Diabetes in those with viral load levels greater than 200 copies/ml was 70% higher compared to those with viral load lower than 75 copies/ml (PR = 1.7 95% CI: 1.3, 2.1).

Table 4 also shows that the adjusted prevalence ratio of Diabetes in those between 35 and 45 years old compared to those younger than 35 was 1.4 (95% CI: 1.2, 1.8).

Patients with BMI below the normal value had 40% less risk of having Diabetes than those with normal BMI (PR= 0.60, 95% CI = 0.4, 0.9), and obese people had a 7% higher risk of having Diabetes than those with normal BMI (PR= 1.07, 95% CI: 0.7, 1.6).

Finally, those with ART treatment for more than 4 years had a 20% lower risk of getting Diabetes than those on ART treatment for less than 2 years (PR = 0.8, 95% CI: 0.6, 0.9).

- **Cancer**

Adjusted and unadjusted prevalence ratios of covariates for Cancer are presented in table 5. The prevalence ratio of Cancer in alcohol consumers compared to non-alcohol consumers was 0.8 (95% CI: 0.5, 0.9).

Those with higher viral load (between 75 and 200 copies/ml) had a 10% higher prevalence of Cancer compared to those with viral load lower than 75 copies/ml (PR = 1.1, 95% CI: 0.9, 1.5)

and those with viral load greater than 200 copies/ml had an equal prevalence of Cancer compared to those with viral load lower than 75 copies/ml (PR = 1.0, 95% CI: 0.6, 1.5).

The prevalence of Cancer in those between 35 and 45 years old was 1.5 (95% CI: 1.1, 2.0). The prevalence ratio of Cancer in those between 45 and 55 years compared to those less than 35 years old was 2.6 (95% CI: 1.8, 3.6), and the prevalence ratio of Cancer in those greater than 45 years old compared to those of less than 35 years-old was 4.1 (95% CI: 3.0, 5.7).

CHAPTER VI: *Discussion*

We explored the association between HIV infection and non-communicable diseases, including Hypertension, type 2 diabetes mellitus, and all type of Cancer in HIV-infected patients at the Donka national hospital in Guinea.

We found that Hypertension's unadjusted and adjusted prevalence ratios were not significantly associated with activities people practiced, residence, daily fruit intake, smoking status, and sex. However, Hypertension was associated with alcohol intake, immunodepression status, age, BMI, and time on ART treatment. The lack of association of Hypertension with sex and smoking status has been previously observed (Niwaha et al., 2021). The findings might be questioned if the data were collected in patients without treatment, as it is established that smokers are more at risk of Hypertension in the general population (Virdis et al., 2010).

In their study on the high prevalence of HIV and non-communicable diseases risk factors in rural Kwazulu-Natal in South Africa, Heerden AV et al. reported a non-significant association between Hypertension and sex and a significant association between Hypertension and age (van Heerden et al., 2017).

Also, we did not find significant prevalence ratios of the associations between Diabetes and profession, residence, HIV type, daily fruit consumption, ART treatment status, smoking status, and sex. We found statistically significant associations between prevalent diabetes and alcohol intake, immunodepression status, age, BMI, and time under ART treatment. The immunodepression status, age, and BMI results align with the literature. Those on alcohol intake and the time on ART treatment do not align with the literature on the risk factors of Diabetes as they are reported in the literature as risk factors for Diabetes in HIV-infected people. Rajagopaul

et al., in their study on the prevalence of diabetes mellitus and Hypertension in South Africa, found significant prevalence ratios for Diabetes with age, BMI, and time on ART treatment. In contrast, the prevalence ratio of Diabetes and sex was not statistically significant (Rajagopaul & Naidoo, 2021). These results align with our findings, which many factors can explain. First, as we reported above, the study took place in the most specialized service in HIV care management within the country. The primary objective of this service is to improve living conditions for HIV-infected people and reduce the risk of having a non-communicable disease in people diagnosed with HIV as much as possible. Cheza A et al. reported a significant association between Diabetes and only the time on ART treatment, which also aligns with the literature review (Cheza et al., 2021).

Finally, we did not find significant prevalence ratios between Cancer and profession, place of residence, HIV type, daily fruit consumption, ART treatment status, sex BMI, and the time under ART treatment. However, those who used alcohol had a lower prevalence of Cancer (adjusting for other variables), as it has been reported in the literature review that alcohol consumption is among the risk factors of developing cancers in the population in general and in HIV-infected people in particular. In this case, the lower prevalence of Cancer in alcohol users can be explained by the non-involvement of alcohol consumption as a risk factor in the occurrence of the most frequent Cancer in this study (Kaposi sarcoma) with 95 cases (41.3% of cancers). On the other hand, it might be explained by social desirability bias, in which patients do not provide correct information to their care provider in order to avoid stigmatization.

Smoking has also been largely reported in the literature as a risk factor for having Cancer in the general population. However, with the most predominant Cancer (41.3 % of Kaposi Sarcoma) being HIV-related, and given that all of the participants were on treatment, it is not unreasonable that the risk of Cancer associated with smoking was insignificant since Kaposi Sarcoma is not

smoking-related Cancer. Older age was associated with a higher risk of Cancer, which could be explained by the fact that Cancer, in general, is more frequent in older people than in younger people (White et al., 2014). It could also be explained by the fact that the cases of Kaposi Sarcoma due to HIV develop in prolonged exposure to HIV (Hernandez-Ramirez et al., 2017).

a- Public Health Implications

This study depicts the profile of non-communicable diseases in HIV-infected people at the Donka National Hospital in Guinea. We identified correlates of the prevalence of each non-communicable disease under investigation: Cancer, Diabetes, and Hypertension. This provides essential preliminary data to help design better intervention and prevention programs, or improve existing programs for those the most in need. For instance, higher age ranges were significantly more likely to have Cancer than those aged 35 years or younger. An example of intervention would be to put people of higher age in close surveillance by identifying the other risk factors for Cancer they might have and respond quickly before it becomes complicated or disseminated. Another intervention would be to select at-risk people and conduct screening whenever possible for early detection. Those improvements or interventions can then be escalated to the hospital, the regional, and even the national levels since the services of infectious diseases within the hospital manage the highest number of HIV-infected people nationwide.

b- Study limitations

This study has limitations. First, the host country has a poor health system, including health coverage. All outcomes of this study are chronic diseases linked to other unknown factors and can be exacerbated by HIV infection or ART treatment but are not necessarily due to HIV. For instance, smoking can cause Cancer; obesity is linked to both Diabetes and Hypertension.

Another limitation is the association between outcomes. Hypertension, for instance, is among the most chronic health condition coexisting with type 2 diabetes (Patel et al., 2018). This study did not examine Hypertension, Diabetes, and cancer co-occurrence. Also, we focused on Cancer in general; however, the effects of HIV infection on cancer occurrence and outcomes are likely to differ based on cancer type. Furthermore, the association between HIV and non-communicable diseases can be confounded by factors (e.g., daily food consumption, exposure to stress, distance from home to the hospital) that were not assessed in this study and that should be the focus of future studies.

Conclusion

Non-communicable diseases are frequent in patients living with HIV. They can be caused by the direct effects of HIV infections on the infected body (intrinsic factors) and the medications or patients' lifestyles (extrinsic factors). This study showed that traditional risk factors for non-communicable diseases in the general population could differ from those in HIV-infected people. However, this should be explored more by other studies comparing risk factors for NCD in HIV and non-HIV people.

It also showed that the care given to HIV-infected people is comprehensive, including preventing or treating non-communicable diseases. It showed a non-significant association between traditional risk factors for NCD in the general population. However, the study could not demonstrate if HIV infection was a causal factor in the occurrence of non-communicable diseases. Moreover, the inter-relation between the non-communicable diseases we studied makes this differentiation even more challenging. Finally, the study could not draw a valid conclusion on the quality of care to prevent non-communicable diseases in HIV-infected people since the study could not compare with non-HIV people.

References:

[1] Overview of Non-communicable Diseases and Related Risk Factors, Department of Health and Human Services Centers for Disease Control and Prevention (CDC) https://www.cdc.gov/globalhealth/healthprotection/fetp/training_modules/new-8/Overview-of-NCDs_PPT_QA-RevCom_09112013.pdf

[2] Non-communicable diseases, World Health Organization (WHO), 2022 https://www.who.int/health-topics/noncommunicable-diseases

[3] The HIV experience and other chronic diseases, UNAIDS, 22 July 2012 https://www.unaids.org/en/resources/presscentre/featurestories/2012/july/20120722chronicdiseases

[4] Kanishka Narayan and Zachary Donnenfeld, *Envisioning a healthy future*, African Futures Paper, Oct 2016, https://apps.who.int/iris/bitstream/handle/10665/41864/0965546608_eng.pdf

[5] GUINEE, ONUSIDA https://www.unaids.org/fr/regionscountries/countries/guinea

[6] Non-communicable diseases, World Health Organization (WHO), 13 April 2021 https://data.worldbank.org/indicator/SH.DTH.NCOM.ZS?end=2019&locations=GN&start=2000&view=charthttps://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

Tables

Table 1: Covariates descriptive statistics by time on ART treatment

Table 2: Covariates descriptive statistics by outcome variable

Characteristics	N (%)	Hypertension	Diabetes	Cancer	P-value
		Time on Antiretroviral Therapy			
		331 (36.74%)	315 (34.96%)	193 (21.42%)	
Profession					
- Always physical activities	552 (61.3)	208 (62.8)	177 (56.2)	118 (61.2)	
- Sometimes physical activities	162 (18.0)	55 (16.6)	60 (19.0)	29 (15.0)	
- No physical activities	186 (20.7)	68 (20.6)	78 (24.8)	46 (23.8)	
Residence					
- Rural	286 (31.7)	229 (69.2)	96 (30.5)	133 (68.9)	
- Urban	615 (68.3)	102 (30.8)	219 (69.5)	60 (31.1)	
5 fruits daily consumption					
- 5 or more fruits daily	274 (30.4)	102 (30.8)	93 (29.5)	56 (29.0)	
- Less than 5 fruits daily	627 (69.6)	229 (69.2)	222 (70.5)	137 (71.0)	
Alcohol Consumption					
- No alcohol intake	609 (67.6)	135 (40.8)	155 (49.2)	46 (23.8)	
- Alcohol intake	292 (32.4)	196 (52.2)	160 (50.8)	147 (76.2)	
ART Treatment					
- Patients on ART treatment	874 (97.1)	329 (97.6)	310 (98.4)	189 (98.0)	
- Patients not on ART treatment	26 (2.9)	2 (2.4)	5 (1.6)	4 (2.0)	
HIV TYPE					
- HIV TYPE1	892 (99.0)	329 (99.4)	312 (99.5)	191 (99.0)	
- HIV TYPE2	9 (1.0)	2 (0.6	3 (0.5)	2 (1.00	
Smoking status					
- Smoker	159 (17.7)	60 (6.7)	55 (17.4)	55 (28.5)	
- No smoker	742 (82.3)	271 (82.3)	260 (82.6)	138 (71.5)	
Immunodepression status					
- 75/ML >= VIRAL LOAD	391 (42.3)	121 (36.6)	99 (31.4)	75 (38.8)	
- 75/ML<VIRAL LOAD<=200/ML	414 (46.0)	164 (49.5)	162 (51.4)	95 (49.2)	
- VIRAL LOAD > 200	106 (11.7)	46 (13.9)	54 (17.2)	23 (12.0)	
Age					
- Less or equal to 35-year-old	574 (63.7)	166 (50.1)	176 (55.9)	91 (47.1)	
- Greater than 35 to 45-year-old	225 (25.0)	116 (35.0)	106 (33.7)	53 (27.5)	
- Greater than 45 to 55 years old	69 (7.7)	36 (10.9)	24 (7.6)	27 (14.0)	
- Greater than 55-year-old	33 (3.6)	13 (3.9)	9 (2.8)	22 (2.4)	
BMI Categories					
- Under Weight (18kg/m2)	100 (11.1)	24 (7.3)	19 (6.0)	22 (11.4)	
- Normal (18-25kg/m2)	554 (61.5)	193 (58.3)	195 (61.9)	122 (63.2)	
- Overweight (>25-30kg/m2)	215 (23.8)	100 (30.2)	88 (28.0)	45 (23.3)	
- Obesity (>30 kg/m2)	32 (3.6)	14 (4.2)	13 (4.1)	4 (2.1)	
Time under ART treatment					
- Less or equal to 2 years	282 (31.3)	124 (37.4)	116 (36.8)	56 (29.0)	
- Between 2 and 4 years	253 (28.0)	87 (26.3)	91 (28.9)	61 (31.6)	
- More than 4 years	366 (40.7)	120 (36.3)	108 (34.3)	76 (39.4)	
Sex					
- Male	427 (47.4)	142 (42.9)	157 (49.8)	97 (50.2)	
- Female	474 (52.6)	189 (59.1)	158 (50.2)	96 (48.8)	

	Total	Unadjusted Prevalence ratio (95% CI)	Adjusted Prevalence ratio (95% CI)
Profession			
- **Always physical activities**	552(61.33%)	Ref	Ref
- **Sometimes physical activities**	162 (18.00%)	0.90 95% CI (0.71 - 1.10)	0.91 95% CI (0.72 -1.15)
- **No physical activities**	186 (20.67%)	0.97 95% CI (0.78 - 1.21)	0.94 95% CI (0.76 -1.16)
Residence			
- **Rural**	286 (31,74%)	Ref	Ref
- **Urban**	615 (68.26%)	1.04 95% CI (0.87- 1.26)	2.38 95% CI (1.15 - 4.94)
5 fruits daily consumption			
- **Less than 5 fruits daily**	627 (69.59%)	Ref	Ref
- **5 or more fruits daily**	274 (30.41%)	1.02 95% CI (0.85 - 1.23)	1.99 95% CI (1.16 – 3.40)
Alcohol Consumption			
- **Alcohol intake**	292 (32.41%)	Ref	Ref
- **No Alcohol intake**	609 (67.59%)	0.70 95% CI (0.59 - 0.82)	0.69 95% CI (0.59 – 0.82)
ART Treatment			
- **Patients on ART treatment**	874 (97.11%)	Ref	Ref
- **Patients not on ART treatment**	26 (2.89%)	0.83 95% CI (0.46 - 1.49)	0.93 95% CI (0.55 - 1.56)
HIV TYPE			
- **HIV TYPE2**	9 (1%)	Ref	Ref
- **HIV TYPE1**	892 (99%)	1.66 95% CI (0.49 - 5.66)	1.84 95% CI (0.48 - 7.10)
Smoking status			
- **No smoker**	159 (17.65%)	Ref	Ref
- **Smoker**	742 (82.35%)	1.03 95% CI (0.83 - 1.29)	1.06 95% CI (0.86 - 1.32)
Immunodepression status			
- **75/ML >= VIRAL LOAD**	381 (42.29%)	Ref	Ref
- **75/ML<VIRAL LOAD<=200/ML**	414 (45.95%)	1.25 95% CI (1.03 - 1.51)	1.18 95% CI (0.98 - 1.42)
- **VIRAL LOAD > 200**	106 (11.76%)	1.37 95% CI (1.05 - 1.78)	1.21 95% CI (0.93 - 1.57)
Age			
- **Less or equal to 35-year-old**	574 (63.71%)	Ref	Ref
- **Greater than 35 to 45-year-old**	225 (24.97%)	1.78 95% CI(1.49 - 2.14)	1.73 95% CI(1.45 - 2.07)
- **Greater than 45 to 55 years old**	69 (7.66%)	1.80 95% CI(1.39 - 2.34)	1.73 95% CI(1.34 - 2.24)
- **Greater than 55-year-old**	33 (3.66%)	1.36 95% CI(0.87 – 2.12)	1.39 95% CI(0.91 - 2.12)
BMI Categories			
- **Normal (18-25kg/m2)**	554 (61.69%)	Ref	Ref
- **Under Weight (18kg/m2)**	100 (11.10%)	0.69 95% CI (0.48 - 0.99)	0.69 95% CI (0.49 - 0.98)
- **Overweight (>25-30kg/m2)**	215 (7.66%)	1.34 95% CI (1.11 - 1.60)	1.29 95% CI (1.07 - 1.56)
- **Obesity (>30 kg/m2)**	32 (3.66%)	1.26 95% CI (0.83 - 1.89)	1.27 95%CI (0.89 - 1.83)
Time under ART treatment			
- **Less or equal to 2 years**	282 (31.30%)	Ref	Ref
- **Between 2 and 4 years**	253 (28.08%)	0.78 95% CI (0.63-0.97)	0.82 95% CI (0.67- 1.02)
- **More than 4 years**	366 (40.62%)	0.75 95% CI (0.61-0.91)	0.77 95% CI (0.64 - 0.94)
Sex			
- **Male**	427 (47.4)	Ref	Ref
- **Females**	474 (52.6)	1.20 95% CI (1.01-1.43)	1.27 95% CI (1.06-1.51)

Table 3: Adjusted and Unadjusted Prevalence ratios for Hypertension

Table 4: Adjusted and Unadjusted Prevalence ratios for Diabetes

	Total	Unadjusted Prevalence ratio (95% CI)	Adjusted Prevalence ratio (95% CI)
Profession			
- **Always physical activities**	552 (61.33%)	Ref	Ref
- **Sometimes physical activities**	162 (18.00%)	1.16 95% CI (0.91 – 1.46)	1.06 95% CI (0.84 -1.34)
- **No physical activities**	186 (20.67%)	1.31 95% CI (1.06 – 1.61)	1.16 95% CI (0.94 -1.43)
Residence			
- **Rural**	286 (31,74%)	Ref	Ref
- **Urban**	615 (68.26%)	1.06 95% CI (0.87 – 1.29)	1.19 95% CI (0.65 – 2.18)
5 fruits daily consumption			
- **Less than 5 fruits daily**	627 (69.59%)	Ref	Ref
- **5 or more fruits daily**	274 (30.41%)	1.96 95% CI (0.79 – 1.17)	1.12 95% CI (0.63 – 1.99)
Alcohol Consumption			
- **Alcohol intake**	292 (32.41%)	Ref	Ref
- **No Alcohol intake**	609 (67.59%)	2.15 95% CI (1.81 – 2.56)	2.01 95% CI (1.69 – 2.39)
ART Treatment			
- **Patients on ART treatment**	874 (97.11%)	Ref	Ref
- **Patients not on ART treatment**	26 (2.89%)	0.54 95% CI (0.25 – 1.20)	0.57 95% CI (0.31 – 1.07)
HIV TYPE			
- **HIV TYPE2**	9 (1%)	Ref	Ref
- **HIV TYPE1**	892 (99%)	1.05 95% CI (0.41 – 2.66)	1.19 95% CI (0.41 – 3.46)
Smoking status			
- **Smoker**	159 (17.65%)	Ref	Ref
- **No smoker**	742 (82.35%)	1.01 95% CI (0.8-1.28)	1.05 95% CI (0.84 – 1.32)
Immunodepression status			
- **75/ML >= VIRAL LOAD**	381 (42.29%)	Ref	
- **75/ML<VIRAL LOAD<=200/ML**	414 (45.95%)	1.51 95% CI (1.22 – 1.85)	1.38 95% CI (1.13 – 1.68)
- **VIRAL LOAD > 200**	106 (11.76%)	1.96 95% CI (1.52 – 2.52)	1.66 95% CI (1.29 – 2.13)
Age			
- **Less or equal to 35-year-old**	574 (63.71%)	Ref	Ref
- **Greater than 35 to 45-year-old**	225 (24.97%)	1.54 95% CI(1.28 – 1.85)	1.49 95% CI (1.29 – 1.78)
- **Greater than 45 to 55 years old**	69 (7.66%)	1.13 95% CI(0.80 – 1.60)	1.08 95% CI (0.78 – 1.49)
- **Greater than 55-year-old**	33 (3.66%)	0.89 95% CI(0.50 – 1.58)	0.96 95% CI (0.56 – 1.63)
BMI Categories			
- **Normal (18-25kg/m2)**	554 (61.69%)	Ref	Ref
- **Under Weight (18kg/m2)**	100 (11.10%)	0.54 95% CI (0.34 – 0.82)	0.60 95% CI (0.40 - 0.89)
- **Overweight (>25-30kg/m2)**	215 (7.66%)	1.16 95% CI (0.98 – 1.37)	1.08 95% CI (0.87 – 1.34)
- **Obesity (>30 kg/m2)**	32 (3.66%)	1.15 95% CI (0.75 – 1.78)	1.07 95%CI (1.66 – 1.73)
Time under ART treatment			
- **Less or equal to 2 years**	282 (31.30%)	Ref	Ref
- **Between 2 and 4 years**	253 (28.08%)	0.87 95% CI (0.70 – 1.09)	0.95 95% CI (0.77 – 1.66)
- **More than 4 years**	366 (40.62%)	0.72 95% CI (0.58 – 0.89)	0.77 95% CI (0.62 – 0.94)
Sex			
- **Male**	427 (47.4)	Ref	Ref
- **Females**	474 (52.6)	0.91 95% CI (0.76- 1.08)	1.04 95% CI (0.87 – 1.24)

Table 5: Adjusted and Unadjusted Prevalence ratio for Cancer

	Total	Unadjusted Prevalence ratio (95% CI)	Adjusted Prevalence ratio (95% CI)
Profession			
- **Always physical activities**	552(61.33%)	Ref	Ref
- **Sometimes physical activities**	162 (18.00%)	0.84 95% CI (0.58 – 1.21)	0.89 95% CI (0.62 -1.29)
- **No physical activities**	186 (20.67%)	1.16 95% CI (0.86 – 1.56)	1.14 95% CI (0.84 -1.55)
Residence			
- **Rural**	286 (31,74%)	Ref	Ref
- **Urban**	615 (68.26%)	1.03 95% CI (0.79 – 1.35)	0.57 95% CI (0.30 – 1.08)
5 fruits daily consumption			
- **Less than 5 fruits daily**	627 (69.59%)	Ref	Ref
- **5 or more fruits daily**	274 (30.41%)	0.94 95% CI (0.71 – 1.21)	0.53 95% CI (0.25 – 1.16)
Alcohol Consumption			
- **Alcohol intake**	292 (32.41%)	Ref	Ref
- **No Alcohol intake**	609 (67.59%)	0.65 95% CI (0.48 – 0.68)	1.63 95% CI (0.47 – 0.85)
ART Treatment			
- **Patients on ART treatment**	874 (97.11%)	Ref	Ref
- **Patients not on ART treatment**	26 (2.89%)	0.71 95% CI (0.29 – 0.77)	0.83 95% CI (0.36 – 1.91)
HIV TYPE			
- **HIV TYPE2**	9 (1%)	Ref	Ref
- **HIV TYPE1**	892 (99%)	0.96 95% CI (0.28 – 3.30)	0.99 95% CI (0.33 – 3.01)
Smoking status			
- **Smoker**	159 (17.65%)	Ref	Ref
- **No smoker**	742 (82.35%)	0.54 95% CI (0.41 – 0.70)	0.53 95% CI (0.41 – 1.69)
Immunodepression status			
- **75/ML >= VIRAL LOAD**	381 (42.29%)	Ref	
- **75/ML<VIRAL LOAD<=200/ML**	414 (45.95%)	1.17 95% CI (0.89 –1.53)	1.09 95% CI (0.85 – 1.41)
- **VIRAL LOAD > 200**	106 (11.76%)	1.10 95% CI (0.73 – 1.67)	1.00 95% CI (0.66 – 1.50)
Age			
- **Less or equal to 35-year-old**	574 (63.71%)	Ref	Ref
- **Greater than 35 to 45-year-old**	225 (24.97%)	1.49 95% CI(1.10 – 2.01)	1.46 95% CI(1.08 – 1.97)
- **Greater than 45 to 55 years old**	69 (7.66%)	2.47 95% CI(1.74 – 3.50)	2.56 95% CI(1.83 – 3.57)
- **Greater than 55-year-old**	33 (3.66%)	4.21 95% CI(3.09 – 5.71)	4.13 95% CI(2.99 – 5.70)
BMI Categories			
- **Normal (18-25kg/m2)**	554 (61.69%)	Ref	Ref
- **Under Weight (18kg/m2)**	100 (11.10%)	1.00 95% CI (0.67 – 1.49)	0.86 95% CI (0.58 - 1.29)
- **Overweight (>25-30kg/m2)**	215 (7.66%)	0.95 95% CI (0.70 – 1.29)	1.00 95% CI (0.75 - 1.32)
- **Obesity (>30 kg/m2)**	32 (3.66%)	0.57 95% CI (0.22 – 1.44)	0.66 95%CI (0.27 - 1.58)
Time under ART treatment			
- **Less or equal to 2 years**	282 (31.30%)	Ref	Ref
- **Between 2 and 4 years**	253 (28.08%)	1.21 95% CI (0.88 – 1.67)	1.24 95% CI (0.91 – 1.68)
- **More than 4 years**	366 (40.62%)	1.05 95% CI (0.77 – 1.42)	1.06 95% CI (0.79 - 1.43)
Sex			
- **Male**	427 (47.4)	Ref	Ref
- **Females**	474 (52.6)	0.89 95% CI (0.69 -1.15)	0.91 95% CI (0.71 -1.16)