Prevalence and Risk Factors of Hypertension Stratified by HIV Status in Western Kenya

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master in Public Health

University of Washington

2020

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Program authorized to offer degree:

Global Health

University of Washington

Abstract

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ABSTRACT

Introduction

The burden of cardiovascular disease (CVD) is increasing in sub-Saharan Africa (SSA) and untreated hypertension is a major contributing factor. The prevalence and risk factors associated with hypertension among PLWHV who are on long-term ART are not well studied and we determined these in a cohort of PLWHV and HIV negative individuals in Kisumu, Kenya.

Methods

In this cross-sectional study, we enrolled 300 PLWHV on long-term ART (≥6 months) and 298 HIV-negative adults seeking routine services at the Kisumu County hospital between 2017-2018. We diagnosed participants with hypertension (defined as blood pressure of ≥140/90mmHg) and used multivariate regression to evaluate the association between hypertension, HIV, other sociodemographic, and CVD risk factors.

Results

The overall prevalence of hypertension was 25% and PLWHV had a lower prevalence of hypertension than HIV-negative persons (18% vs 33% respectively; $p<0.001$). After adjusting for age, body mass index, education level, interleukin-6 and central obesity, PLWHV were 48% less likely to have hypertension (adjusted relative risk (aRR) 0.52; 95% confidence interval (CI) 0.39-0.71). Participants aged 40-50 years had a 4.19 times higher risk of hypertension (95% CI 2.59-6.79) and those >51 years had a 4.66-fold higher hypertension risk (95% CI 2.62-8.29)

compared to individuals <40 years old. Individuals with BMI of <18 kg/m^2 were 1.76 times more likely to have hypertension (95% CI:2.59-6.79); those with BMI 25-30 kg/m^2 had 1.73 times higher likelihood of being hypertensive (95% CI 1.12-2.68), and those with BMI >30 kg/m^2 had a 2.65 fold-greater risk of hypertension (95% CI 1.55-4.50) compared to those with BMI in the normal range (18-25 kg/m^2).

Conclusion

We found a high prevalence of hypertension overall, and this was associated with advancing age and higher BMI. PLWHV on stable ART had a lower prevalence compared to HIV-negative individuals.

INTRODUCTION

Hypertension (HTN) is a major modifiable risk factor for cardiovascular diseases (CVD), however, diagnosis and treatment are often delayed due to its asymptomatic nature, leading to increased risk of complications and mortality (1). The World Health Organization's 2017 report on non-communicable diseases (NCD) risk factors identified high blood pressure as the leading cause of death across income levels (2). In 2015, hypertension caused an estimated 7.5 million deaths, accounting for 12.8% of all deaths globally (3). While most deaths occur in high-income countries, sub-Saharan Africa (SSA) is facing a dual burden of communicable and NCD including CVD and cancers, with fewer resources for managing NCD (2,4,5).

Although modest improvements have been made in the management of hypertension in SSA, screening, diagnosis, and treatment remain inadequate (6). The WHO estimates that 46% of individuals >25 years of age in Africa have hypertension, with rates increasing rapidly due to demographic transitions, urbanization, and technological advancements leading to a more sedentary lifestyle, along with increased prevalence of smoking, harmful alcohol use and consumption of processed foods (4,7,8). Estimates of hypertension prevalence in Kenya is high (ranging from 12.6 - 36.9%) with higher rates in urban areas (4,9,10). Older age, higher body mass index (BMI), harmful alcohol consumption, cigarette smoking and higher socioeconomic status have been associated with hypertension in previous studies in Kenya (10–13)

With the universal availability of ART for individuals testing HIV positive, people living with HIV (PLWHV) on ART have a near-normal life expectancy and are at risk of NCD, many of which occur later in life as a result of behavioral risk factors and aging. In addition to the already known traditional lifestyle risk factors (refined food, sedentary lifestyle and harmful use of alcohol and smoking), PLWHV on ART may be at higher risk for non-communicable diseases including hypertension due to persistent immune activation, inflammation and endothelial dysfunction that leads to reduced elasticity of blood vessels and increased risk of high blood pressure (14,15), which can increase the risk of progression to CVDs (16,17). However, studies evaluating the impact of HIV on immune activation have shown varied results. Some studies show that PLWHV achieving viral suppression on ART have a plateau of inflammatory markers so may have lower HIV-related inflammation due to long-term ART. In contrast, other studies however found soluble inflammatory markers (interleukin 6 [IL-6] and high sensitivity C-reactive

protein (hsCRP) to remain elevated) even with undetectable viremia, which may lead to a higher risk CVDs and hypertension for PLWHV compared to the general population (18,19). While several studies have compared hypertension and inflammatory markers among PLWHV, few have been conducted among PLWHV on who are virally suppressed and on long-term ART compared to HIV negative individuals in SSA (15,18,20,21). High sensitivity C-reactive protein (hs-CRP) and interleukin 6 (IL-6), have also been found to be more elevated in individuals with hypertension than those with normal blood pressure (22).

We sought to estimate the prevalence of hypertension among PLWHV on long-term ART compared to HIV negative adults in western Kenya and identify predictors of hypertension, including inflammatory markers to inform targeted interventions.

METHODS

Study design and setting

We used data from a cross-sectional study assessing CVD risk factors among PLWHV on ART and HIV negative adults enrolled between 2017-2018 at the Kisumu County Hospital (KCH) in Western Kenya. A detailed description of the recruitment strategy and study procedures are presented in the parent study (23). Briefly, participants who were ≥30 years old living within a 50 km radius of the hospital and seeking routine services at KCH were eligible to participate in the study. Eligibility criteria for PLWHV included being enrolled in a HIV comprehensive care clinic (CCC) and on antiretroviral treatment (ART) for at least 6 months. HIV negative persons were recruited from the voluntary HIV testing and counseling (HTC) services at KCH. The study enrolled 300 HIV-negative individuals and 300 PLWHV using stratified sampling to ensure an equal number of males and females.

Ethical approval

We obtained ethical approval from the University of Washington Institutional Review Board and the University of Nairobi and Kenyatta National Hospital Ethics Review Committee. Written informed consent was obtained from all participants before initiating study procedures.

Study procedures

Trained nurse counselors collected data on sociodemographic and behavioral characteristics, HIV status and hypertension risk factors using a structured questionnaire adapted from the validated WHO STEPwise approach for chronic disease risk factors surveillance modified to the Kenyan context (24,25). Two blood pressure readings were taken on each arm 5 minutes apart using a digital blood pressure machine (CH 453, Omnia Health). Hypertension was classified according to the Kenya guidelines on hypertension classification which are adopted from the Eighth Joint National Committee on Prevention, Detection, Evaluation, and Treatment of high blood pressure (JNC VIII) that defines hypertension as having a mean systolic blood pressure of ≥140mmHg or diastolic blood pressure ≥90mmHg(26,27). Weight (in Kg) and height (in cm) was measured using the weight-height gauge (Model: ZT-150A body-weight balance, Ningbo TianHou, China (Mainland)).

Fasting blood samples were collected at the clinic, processed at Kenya Medical Research Institute Centers for Disease Control and Prevention lab in Kisumu (KEMRI/CDC), Kenya then shipped to Seattle, USA for testing of IL-6 and hs-CRP. Testing for CD4 T-cell count and viral load for PLWHV was done locally at the KEMRI/CDC lab. A detailed description of laboratory procedures is given elsewhere (23).

Definition of variables

The primary outcome hypertension was defined as having a mean systolic blood pressure ≥140mmhg or diastolic blood pressure ≥90mmhg or self-report of previous hypertension diagnosis by a health care provider and/or if currently taking anti-hypertensive drugs within the last two weeks according to Kenya CVD guidelines (27). Previously diagnosed hypertension was defined as a reported diagnosis from a health care provider or taking antihypertensive drugs. treatment of hypertension was defined as taking antihypertensive medications within the last two weeks. Blood pressure control was defined as being on treatment within the last two weeks and having a blood pressure reading of less than 140/90mmHg.

Body Mass Index (BMI) was computed from weight (kilograms) and height (meters). BMI was classified as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) or obese (≥30

kg/m^2). Adequate physical activity was defined by getting at least 150 minutes of moderate work or sports or at least 75 minutes of vigorous intensity work or sport per week as per WHO recommendations (28). Current alcohol intake and cigarette smoking were defined as consumption and or smoking within the past 30 days. Adequate fruit and vegetable intake was defined as at least 5 servings per day. Abdominal obesity was defined as a waist circumference of >88 cm in females and >94 cm in males while central obesity as a hip-waist ratio of >0.80 in females and >0.90 in males based on the WHO recommendations (29).

High sensitivity C-reactive protein was classified as hs-CRP<1mg/L as low risk, between 1 and 3 mg/L as moderate risk, and >3 mg/L as high risk (30). A viral load of less than 1000 copies/mL was defined as low-level viremia while viral load <50 copies/mL defined as undetectable based on the current Kenya 2018 guidelines on use of ART regimens for treatment and prevention of HIV (31) .

Statistical analyses

Continuous variables were analyzed using student t-test and categorical variables were evaluated using chi-square tests. Proportions were computed to assess the prevalence of hypertension. univariate and multivariable poisson regression with robust standard errors to assess the association between participant characteristics and hypertension. all analyses were conducted using Stata version 15.0 (Stata Corp. College Station TX).

RESULTS

Participant Characteristics

Of the 600 participants enrolled in the parent study, 598 participants were included in the present analysis: 300 PLWHV and 298 HIV negative participants, 50% were female. Two participants were excluded due to missing data. **Table 1** displays the characteristics of the study participants. The median age was 39.5 (interquartile range [IQR] 45, 53) years in PLWHV and 40 (31, 55) for the HIV negative participants. More than three quarter of the participants (86%) had completed at least primary level education and more than half (69%) were formally employed. The mean BMI was 23.3 (95% CI: 22.7, 24.7) in PLWHV and 25.1 (95% CI: 24.4, 25.8) in HIV negative individuals (p-value <0.001). A third of the participants (34%) were either obese or overweight and a larger proportion of HIV-negative participants were overweight/obese compared to PLWHV (42% vs 27% respectively,

p-value 0.001). Abdominal obesity was also higher in HIV-negative individuals compared to PLWHV (28% vs 19% respectively, p-value 0.01). Overall, current alcohol consumption and smoking rates were low (12% vs 5% respectively) in our study population with no significant differences between the groups. There were no differences in the distribution of hs-CRP (p-value 0.17). Among PLWHV, the median (IQR) time since diagnosis of HIV and ART use was 9 (5,11) years and 8 (IQR 4,10) years respectively. The median (IQR) CD4 count was 512 (364, 666) cells/mm^3 and 96% were virally suppressed. Most (87%) of PLWHV were on first line ART (non-protease inhibitor-based regimen).

Hypertension prevalence, awareness, treatment and control

The overall prevalence of hypertension was 25%. Over one-third (33%) of HIV negative individuals and 18% of PLWHV were hypertensive (p-value <0.001). Of the 152 individuals with hypertension, (71) 47% reported a previous diagnosis of hypertension with 37% of these reporting taking antihypertensives in the last two weeks. Less than a quarter (23%) of those on medication were achieving blood pressure control.

Risk factors of hypertension

Demographic, behavioral, and physical measurements comparing individuals with and without hypertension are displayed in **Table 2**. Compared to normotensive, individuals with hypertension were more likely to be >40 years (85% vs 57% ; p-value <0.001), have a BMI >25 kg/m^2 (55% vs 28%; p-value <0.001) and to be HIV negative (64% vs 45%; p-value <0.001) with no significant gender differences. There were no major differences in self-reported lifestyle characteristics between the groups. Abdominal and central obesity were significantly associated with an increased likelihood of hypertension (**Table 2**).

Table 3 presents the univariate and multivariate associations between hypertension and covariates. In the univariate analysis, HIV status, age categories, BMI, education level, IL 6 and abdominal obesity were associated with hypertension. In the multivariable model, only HIV status, age categories and BMI remained significantly associated with hypertension. PLWHV were 48% less likely to have hypertension compared to HIV negative individuals (95% CI: 0.39-0.71). The risk of hypertension increased with age in a dose-response manner; the risk

was 4.19 higher among persons who were age 40-50 years (95% CI: 2.59-6.79) and 4.66 higher among those >51 years (95% CI: 2.62-8.29) compared to those age 30-40 years. Similarly, the risk of hypertension was greater in those with higher in BMI; individuals who were overweight (25-30 kg/m^2) were twice as likely to have hypertension (95% CI: 1.12-2.54) while the obese (>30 kg/m^2) were 2.65 times more likely to have hypertension (95% CI: 1.55-4.50) compared to those with normal weight (18-25 kg/m^2). Being underweight was similarly found to be associated with hypertension (aRR 1.76; 95% CI: 1.03-3.01). Education and abdominal obesity were not associated with hypertension after adjusting for other risk factors.

Restricting our analysis to PLWHV, only age and BMI >30 kg/m^2 were statistically significantly associated with hypertension in the multivariate regression. Hypertension was not found to be associated with education level, abdominal obesity, alcohol intake, smoking status, physical activity, fruit and vegetable servings, hs-CRP and IL-6 or HIV related characteristics (Table 4).

DISCUSSION

We found that a quarter of participants in our study had hypertension and among those slightly more than half had a new diagnosis of hypertension. The estimates of hypertension found in our study are similar to those reported in the Kenyan national survey on non-communicable diseases (24.5%), other studies conducted in Kenya (10,12,32) and in the sub-Saharan African (SSA) region (20). Prevalence of undiagnosed hypertension was high in both HIV-negative and PLWHV, highlighting the need to scale-up sustainable platforms to increase screening coverage for hypertension. Similar to the numerous approaches used to increase population coverage of HIV testing, including offering screening in hospitals and community-based settings, a broad array of interventions are needed to improve identification and treatment of hypertensive patients.

Notably, we found that hypertension prevalence was higher in the HIV negative individuals compared to PLWHV, which does not support the hypothesis that PLWHV are at increased risk of hypertension because of increased immune activation and inflammation (33,34). Previous studies assessing hypertension by HIV status have yielded conflicting results. Population-based surveys conducted in Uganda and North Tanzania also found higher rates of hypertension in HIV-negative individuals compared to PLWHV (14% vs 11% in Uganda and 8.2% vs

5.3% respectively) (20,21). The authors of these studies suggest that HIV-negative individuals may have more anxiety related to seeing a healthcare provider which may lead to a higher blood pressure measurement compared to PLWHV who have greater contact with the healthcare system. They also posit that hypertension prevalence in PLWHV is attributed to survival bias, assuming that persons with both HIV and hypertension may have higher death rates (21). In our study, anxiety is unlikely to influence our study findings as HIV negative individuals in our study were recruited after seeing healthcare providers at the clinic for HIV testing. In contrast, a cross-sectional study conducted in Tanzania before the launch HIV treatment as prevention, found that PLWHV on ART had higher hypertension prevalence (28.7%) compared to HIV negative individuals (16.3%) while PLWHV who were ART naïve had the lowest hypertension prevalence (5.3%); although this study did not conduct an adjusted analysis (15). Therefore, it is possible that early initiation of ART after HIV diagnosis combined with high adherence can reduce the risk of hypertension among PLWHV. Traditional risk factors played a significant role in the higher prevalence of hypertension. HIV negative individuals were more likely to be obese and overweight and less likely to meet the recommended physical activity putting them at a higher risk of hypertension. A possible explanation for this is the regular contact of PLWH to the health care workers during their routine visits therefore receive additional counseling on lifestyle changes to prevent NCDs whereas HIV negative are not in regular contact with the health care system.

We found that less than 50% of individuals with previously diagnosed hypertension were taking antihypertensive medication, and among those on treatment, many had not achieved controlled hypertension. It was surprising that most of the individuals on treatment for hypertension were HIV negative which highlights there is a gap in follow-up of PLWH with hypertension as a comorbid, yet they seek routine services. Previous studies have found suboptimal treatment adherence and control of blood pressure in SSA. A population-based survey conducted in Uganda found that 14% of individuals with known hypertension were on medication and less half of these achieving controlled hypertension (20). The national survey in Kenya found that approximately 40% of those with known hypertension were on treatment, 49% of whom had achieved blood pressure control (1,12). These studies highlight the gap between hypertension screening and linkage to treatment. Interventions are urgently needed to

increase treatment uptake and monitor treatment adherence to reduce the risk of complications related to uncontrolled hypertension.

In multivariate analysis, hypertension was associated with older age, higher BMI, and HIV-negative status. These results are similar to previous studies conducted in SSA and the which find age and BMI are associated with risk of hypertension (12,13,35,36). Surprisingly, we did not find an association between known risk factors of hypertension (physical activity, diet, socioeconomic status, alcohol intake and cigarette smoking) and hypertension, which may be due to imprecise measurements of these factors or social desirability bias due to self-report. These results are partially consistent with the 2015 national survey on prevalence and determinants of hypertension in Kenya which additionally highlighted the potential of this phenomenon affecting reporting (32). While there may be under reporting, traditional risk factors for hypertension may possibly be causing the difference seen between PLWHV and HIV negative participants. Results of our sub-analysis restricted to PLWHV found that ART regimen, duration of time on ART, viral load, current and nadir CD4 T cell count viral load were not associated with hypertension, which is similar to findings from previous studies (20,37). This may be due to PLWHV in our sample consisting of mainly of individuals with high CD4 count who were virally suppressed.

A limitation of our study is it is a cross-sectional design which prevents the assessment of temporal relationships. Additionally, the study population was recruited from one study clinic and may not generalize to other settings. However, we recruited HIV negative persons seeking routine HIV testing services which is likely representative of healthy individuals in the community. In addition, PLWHV in our study were on long-term ART and nearly all were virally suppressed, therefore, we cannot assess the association between HIV and hypertension among PLWHV who are ART naïve or not suppressed on ART. Further, due to incomplete data on socioeconomic status which has been associated with hypertension in literature, there is a possibility of residual confounding. Finally, diagnosis of hypertension requires multiple measurements however due to the nature of the study we only had measurements for one day. This may overestimate the true prevalence of hypertension in this cohort; however, we tried to mitigate this by taking several blood pressure readings with rest intervals between the readings.

Our study has several strengths. We enrolled a large sample both PLWHV and HIV negative participants from the same region, therefore can be generalized to this population. PLWHV in our study population were stable

on ART with most achieving viral suppression compared to the HIV negative population. Few studies in the region have compared these two population after the roll out of test and treat programs in Kenya.

CONCLUSION

Our assessment of PLWHV with low HIV viremia suggests that HIV may not increase hypertension in those on long-term ART. We found a high prevalence of hypertension along with a large proportion of undiagnosed hypertension, indicating that increasing routine hypertension screening is crucial to identifying those at high risk of cardiovascular disease, particularly among older individuals and those who are overweight/obese. Additionally, strong referral systems to link individuals diagnosed with hypertension to treatment can reduce complications due to cardiovascular disease.

ACKNOWLEDGMENTS

We thank the study team, study participants, collaboration from University of Washington, USA, University of Makerere, Kampala, Uganda, Ministry of Health, Kenya, Kenyatta National Hospital, Kenya and Kisumu County Hospital, Kenya.

AUTHOR DISCLOSURE STATEMENT

The authors declare that they have no conflicts of interest or competing financial interests.

FUNDING

This study was supported by US National Institutes of Health (NIH), R21 TW010459 and JNM received support from the Fogarty International Center (FIC) D43 TW009580. MS received support from NIMH K01MH115789. The funders had no role in study design, data collection, analysis, writing of the report, nor the decision to submit for publication.

TABLES

Table 1: Participant characteristics stratified by HIV status[§]

	Overall N= 598 n(%)	HIV +, N=300 n(%)	HIV -, N=298 n(%)	p-value
Gender (Male)	299 (50)	150 (50)	149 (50)	1.00
Age groups (years)*				
30-39	213 (36)	75 (25)	138 (46)	
40-50	303 (50)	195 (65)	108 (36)	<0.001
>50	82 (14)	30 (10)	52 (17)	
Level of Education				
None	85 (14)	39 13	46 15	
Primary level	227 (38)	130 43	97 33	0.025
More than primary level	286 (48)	131 44	155 52	
BMI (kg/m^2)*				
<18(underweight)	43 (7)	25 (8)	18 (6)	
≥18-<25 (normal)	349 (58)	193 (64)	156 (52)	
≥25-<30 (overweight)	128 (21)	57 (19)	71 (24)	0.001
≥30 (obese)	78 (13)	25 (8)	53 (18)	
Marital Status				
Currently married	440 (74)	205 (68)	235 (79)	
Never married	38 (6)	15 (5)	23 (8)	<0.001
Divorced/Separated/Widowed	120 (20)	80 (27)	40 (3)	
Occupation				
Employed	411 (69)	208 (69)	203 (68)	
Casual Laborer	100 (17)	52 (17)	48 (16)	0.68
Unemployed	87 (15)	40 (13)	47 (16)	
Alcohol consumption*				
Never	401 (67)	204 (68)	197 (66)	
Previous	123 (21)	64 (21)	59 (20)	0.43
Current	74 (12)	32 (11)	42 (14)	
Smoker				
Never	524 (88)	261 (87)	263 (88)	
Previous	45 (7)	27 (9)	18 (6)	0.26
Current	29 (5)	12 (4)	17 (6)	
Insufficient fruit and vegetable servings	551 (93)	282 (94)	269 (91)	0.1
Insufficient physical Activity	258 (43)	113 (38)	144 (48)	0.01
Central obesity	292 (49)	156 (52)	136 (46)	0.12
Abdominal obesity	140 (23)	56 (19)	84 (28)	0.006
hsCRP				
Low (<1mg/L)	58 11)	23 (8)	35 (13)	0.17
Moderate (1- 3mg/L)	341 (60)	175 (61)	166 (60)	
High (>3mg/L)	165 (29)	89 (31)	76 (27)	
HIV related characteristics				
Undetectable viral load		213 (71)		
Virally suppressed		285 (96)		

ART regimen				
PI based		40 (13)		
Non-PI based		260 (87)		

[§]BMI-body mass index. Inadequate fruit and vegetable servings: Less than 5 servings per day. Physical inactivity: < 150 minutes of moderate intensity physical activity or < 75minutes of vigorous physical activity per week. Central obesity: waist-hip ratio >0.90 males and >0.80 females. Abdominal obesity: waist circumference >94cm in men and 88cm in female. hsCRP-high sensitivity C reactive protein. Undetectable viral load-viral load <50copies/mL. Virally suppressed: viral load <1000copies/mL. *Due to rounding some proportion do not add up to 100%.

Table 2: Characteristics of participants stratified by hypertension status [†]

	Hypertension N (%)	**No hypertension N(%)**	**p-value**
Age groups (years)*			
30-39	23 (15)	190 (43)	
40-50	93 (61)	210 (47)	**< 0.001**
>50	36 (24)	46 (10)	
Gender			
Female	80 (53)	219 (49)	0.45
Male	72 (47)	227 (51)	
Level of Education			
None	31 (20)	54 (12)	
Primary level	53 (35)	174 (39)	**0.041**
Secondary level and above	68 (45)	218 (49)	
BMI (kg/m^2)			
<18(underweight)	11 (7)	32 (7)	
≥18 - <25 (normal)	57 (38)	292 (65)	**< 0.001**
≥25 - <30 (overweight)	40 (26)	88 (20)	
≥30 (obese)	44 (29)	34 (8)	
HIV Status			
PLHIV	55 (36)	245 (55)	**< 0.001**
HIV negative	97 (64)	201 (45)	
Inadequate fruits and vegetable servings	141 (92)	410 (94)	0.45
Alcohol consumption			
Never	110 (72)	291 (65)	0.25
Previous	25 (16)	98 (22)	
Current	17 (11)	57 (13)	
Smoker			
Never	136 (89)	388 (87)	
Previous	7 (5)	38 (9)	0.24
Current	9 (6)	20 (4)	
Insufficient Physical activity	63 (41)	207 (46)	0.29
Central obesity	92 (61)	200 (45)	**0.001**
Abdominal obesity	55 (36)	63 (14)	**< 0.001**

hs-CRP *			
Low (<1mg/L)	9 (7)	49 (13)	
Average (1- 3mg/L)	83 (67)	258 (67)	0.17
High (>3mg/L)	32 (26)	80 (20)	

† BMI-body mass index. Physical inactivity: < 150 minutes of moderate intensity physical activity or < 75minutes of vigorous physical
activity per week. Central obesity: waist-hip ratio >0.90 males and >0.80 females. Abdominal obesity: waist circumference >94cm in men
and 88cm in female. hsCRP-high sensitivity C reactive protein. Undetectable viral load-viral load <50copies/mL. Virally suppressed: viral load <1000copies/mL. *Due to rounding some proportion do not add up to 100%.*n=564

Table 3: Univariate and multivariate associations between risk factors and hypertension						
	Univariate RR	**95% CI**	**p-value**	**Multivariate RR**	**95% CI**	**p-value**
HIV Status: Negative	1.00			1.00		
Positive	0.56	(0.42-0.75)	**< 0.001**	0.52	(0.39-0.71)	**< 0.001**
Gender: Female	1.00	(0.68-1.19)	(0.45)			
Male	0.90					
Age: (years) <40	1.00					
40-50	2.84	(1.86-4.33)	**< 0.001**	4.19	(2.59-6.79)	**< 0.001**
>50	4.07	(2.57-6.42)	**< 0.001**	4.66	(2.62- 8.29)	**< 0.001**
BMI (kg/m^2): 18-25	1.00					
<18	1.57	(0.89-2.74)	**0.01**	1.76	(1.03-3.01)	**0.038**
25-30	1.91	(1.34-2.72)	**< 0.001**	1.73	(1.12-2.68)	**0.014**
>30	3.45	(2.54-4.69)	**< 0.001**	2.65	(1.55-4.50)	**< 0.001**
Level of Education						
None	1.00					
Primary level	0.64	(0.44-0.92)	0.02	0.84	(0.56-1.27)	0.4
≥ Secondary level	0.65	(0.46-0.92)	0.02	0.82	(057-1.19)	0.3
hsCRP: Low	1.00					
Moderate	1.57	(0.84-2.94)	0.16	1.3	(0.68-2.47)	0.43
High	1.84	(0.94-3.59)	0.07	1.09	(0.55-2.16)	0.81
Interleukin 6: (IL6)	1.03	(1.01-1.05)	**< 0.001**	1.02	(1.00-1.04)	0.07
Abdominal obesity	2.38	(1.83- 3.09)	**< 0.001**	0.98	(0.62-1.53)	0.9
Alcohol intake						
Never	1.00					
Previous	0.92	(0.62-1.37)	0.67	0.70	(0.68-2.47)	0.07
Current	0.66	(0.43-1.02)	0.06	0.95	(0.58-1.56)	0.85
Smoker						
Never	1.00					
Previous	0.59	(0.29-1.20)	0.15			
Current	1.19	(0.68-2.09)	0.53			
Physical activity	1.16	(0.87-1.54)	0.29			
Sufficient Fruits and vegetable servings	1.19	(0.87-1.61)	0.27			

*Adjusting for age, BMI, education, IL6 and central obesity, the likelihood of having hypertension in the PLWHV is 48% lower than in the HIV negative. aRR: adjusted relative risk. hs-CRP: high sensitivity C reactive protein.

Table 4: Univariate and multivariate associations between hypertension and risk factors among PLHIV						
	Univariate RR	95% CI	p-value	Multivariate RR	95% CI	p-value
Age: <40 years	1.00					
40-50 years	5.64	(1.80-17.65)	**0.003**	5.12	(1.61-16.29)	**0.01**
>51 years	6.67	(1.89-23.49)	**0.003**	6.77	(1.83-24.98)	**0.01**
BMI 18-25	1.00					
(kg/m^2): <18	1.78	(0.81-3.91)	0.15	1.58	(0.73-3.42)	**0.25**
25-30	1.69	(0.93-3.08)	0.084	1.58	(0.73-3.41)	**0.25**
>30	2.96	(1.63-5.41)	**< 0.001**	2.42	(1.05-5.61)	**0.04**
Level of Education						
None	1.00					
Primary level	0.94	(0.46-1.91)	0.86			
≥Secondary level	0.82	(0.39-1.69)	0.59			
Abdominal obesity	2.12	(1.31-3.44)	0.02	1.17	(0.56-2.45)	0.68
Alcohol intake						
Never	1.00					
Previous	0.65	(0.32-1.33)	0.24			
Current	1.31	(0.67-2.54)	0.43			
Smoker						
Never	1.00					
Previous	0.39	(0.10-1.54)	0.18			
Current	1.78	(0.77-4.11)	0.18			
Insufficient physical activity	0.92	(0.56-1.53)	0.76			
Insufficient fruit & vegetable servings	0.76	(0.31-1.88)	0.56			
hs-CRP: Low (<1mg/L)	1.00					
Moderate (1- 3mg/L)	1.57	(0.84-2.94)	0.16	1.08	(0.42-2.79)	0.87
High (>3mg/L)	1.84	(0.94-3.59)	0.07	0.97	(0.35-2.65)	0.95
Interleukin 6	0.98	(0.83-1.14)	0.78			
Viral load						
≥1000copies/mL^3	1.00					
<1000copies/mL^3	1.39	(0.37-5.19)	0.62			
Current CD4 count						
≥500 cells/mm^3	1.00					
<500 cells/mm^3	0.96	(0.59-1.55)	0.87			
ART regimen						
Non-PI based	1.00					
PI based	0.65	(0.28-1.53)	0.33			
ART duration (years)	1.04	(0.99-1.10)	0.14			

aRR: adjusted relative risk. hs-CRP: high sensitivity C reactive protein. PI: protease inhibitors

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