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ORIGINAL RESEARCH

Prevalence and Factors Associated with Hypertension Among HIV Positive Patients on Antiretroviral Therapy: A Hospital-Based Cross-Sectional Study in Rwanda

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Introduction: The human immunodeficiency virus (HIV) and the use of antiretroviral therapy (ART) are influential elements contributing to hypertension, which is a public health concern particularly in sub-Saharan Africa where its underdiagnosis and limited investigation persist. Moreover, hypertension prevails at higher rates among individuals living with HIV (PLWH) in comparison to the general population. Therefore, our study determined the prevalence of hypertension and its associated factors among PLWH who are undergoing ART treatment at Byumba District Hospital.

Methods: A cross-sectional study design was conducted among 406 PLWH over the age of 14 years who were undergoing ART within the HIV department. We performed statistical analyses using STATA version 13. Significant independent variables identified in the bivariate analysis were further exported in a multivariable logistic regression model to ascertain their association with hypertension. This model elucidated factors associated with hypertension, presenting outcomes through odds ratios and their respective 95% confidence intervals, with statistical significance set at $p < 0.05$.

Results: The prevalence of hypertension was 24.7%, which means that roughly 1 in 4 PLWH were hypertensive. Notably, individuals aged 41 years and above demonstrated a significant association with heightened hypertension [AOR = 4.49; 95% CI = 2.45–8.21, $p < 0.001$] in contrast to those aged between 14 and 40 years. Additionally, smokers [AOR = 12.12; 95% CI = 4.48–32.74, $p < 0.001$] and individuals with a family history of hypertension [AOR = 4.28; 95% CI = 1.01–18.13, $p = 0.049$] demonstrated a higher likelihood of hypertension than their counterparts. Moreover, alcohol consumers [AOR = 5.5; 95% CI = 2.75–10.9, $p < 0.001$] had an increased likelihoods of hypertension compared to non-drinkers. Lastly, diabetics were almost 6 times more likely to be hypotensive [AOR = 4.50; 95% CI = 2.55–7.95, $p = 0.018$] when compared to those without diabetes.

Conclusion: Our findings strongly underscore the urgency for the implementation of targeted programs aimed at enhancing awareness and comprehension of the factors and potential complications tied to hypertension among PLWH. Such programs could be integrated into routine HIV care services to provide patients with the information and skills required to manage their hypertension effectively.

Keywords: hypertension, prevalence, people with human immunodeficiency virus, antiretroviral therapy, Byumba hospital

Introduction

The Human Immunodeficiency Virus (HIV) poses a significant global public health threat, with its increasing association with cardiovascular complications, cerebral-vascular incidents, and vasculopathy over the past two decades.[1] These HIV-related complications contribute to elevated mortality and morbidity rates in both developed and developing countries.[2,3]

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Hypertension, a top contributor to cardiovascular diseases and a global leading cause of death, is notably prevalent among individuals with diabetes, with over 45% of diabetic patients succumbing to complications related to hypertension.[4–6] To combat this health concern, antiretroviral therapy (ART) plays a essential role in enhancing the quality of life for people living with HIV (PLWH).[7,8] Globally, recent reports indicated 38.4 million people living with HIV (PLWH) of which 25.4 million PLWH access to ART. This pandemic remains harmful in Sub-Saharan African (SSA) region where one in 25 adults has been living with HIV accounting two-thirds of global cases.[9,10] Prior studies stated that hypertension remains inadequately addressed and diagnosed within the rural areas from SSA.[7,8] Additionally, studies have shown that individuals on ART are prone to alterations in lipoprotein density cholesterol (HDL) or high-density lipoprotein levels, elevating their hypertension risk.[11] The target to achieve the third Sustainable Development Goal (SDG-3) is to reduce HIV/AIDS prevalence by 90% by 2030. This necessitates intensive efforts on hypertension management and the spread of sexually transmissible infections.[12]

Although the prevalence of hypertension among PLWH is relatively lower in SSA and Asia compared to North America, Europe, and South America, the impact is more pronounced in SSA.[8,13] The World Health Organization (WHO) forecasts an increase in non-communicable diseases (NCDs), with hypertension driving complications such as diabetes, stroke, and ischemic heart diseases.[8] While only 16.2% of individuals in SSA countries have hypertension, a significant proportion consists of HIV-positive patients.[7,14] In Rwanda, hypertension prevalence was 15.6%, rising with age.[15,16]

Earlier research has comprehensively documented a range of factors that contribute to hypertension among PLWH. These factors encompass various behavioural aspects, including poor nutritional habits, non-compliance with prescribed treatments, alcohol consumption, and smoking.[17,18] Moreover, the frequencies of clinical visits and engagement in physical activity, including sports participation, have been recognized as contributing factors.[19,20] Socio-demographic factors, such as place of residence or urbanization, age, gender, education, and marital status, also influence the occurrence of hypertension among PLWH. For instance, hypertension tends to be more prevalent among adult PLWH compared to their younger counterparts.[21] This health concern is intricately linked with clinical factors, such as longer duration of HIV infection, a family history of hypertension, low CD_4 cell count, elevated viral loads, diabetes, an extended duration of HIV infection, and specific medication use, often in conjunction with ART.[22,23] Additionally, a higher body mass index has been identified as another risk factor for hypertension. Notably, the utilization of ART has previously been acknowledged as a contributing factor underlying hypertension among PLWH.[7,24]

Previous studies underscore the fact that a considerable number of individuals are unaware of their hypertension status.[19,25] Rwanda is positioned among countries undergoing developmental transitions, with a heightened focus on the epidemiology of hypertension. This health concern has been recognized as a multifaceted catalyst for diverse health complications, contributing to increased morbidity and mortality in the absence of early preventive measures and treatments. Within the Rwandan population, a study conducted in 2013 revealed a prevalence of 36.1% of cardiovascular disease (CVD) among workers, of which approximately 33% were unaware of their hypertension diagnosis.[15] Moreover, the context of HIV infection has shown associations with subclinical atherosclerosis indicators, including markers of endothelial dysfunction, escalated arterial stiffness, and atherosclerotic progression.[26,27] These factors collectively increase the vulnerability of individuals to hypertension, particularly when combined with other recognized hypertension risk factors, such as being aged 45 years and above, being male, engaging in smoking and alcohol use, grappling with obesity and diabetes, maintaining a sedentary lifestyle, and possessing a family history of hypertension.[28–30]

Poorly controlled hypertension stands as a significant contributor to cardiovascular disease not only in HIV patients but also general population of sub-Sahara Africa.[31,32] This exerts a profound impact on overall health outcomes.[33] The increasing adoption and adherence to ART among PLWH might hold potential in addressing this prevalent health issue. As hypertension is a substantial risk factor of cardiovascular disease, understanding its prevalence and its determinants among PLWH assumes paramount importance for policymakers and the affected community. Yet, despite the awareness of hypertension as a public health concern, a critical research gap persists particularly in the rural settings of Rwanda. This study aims to fill this critical gap by rigorously examining the prevalence of hypertension and its associated factors among HIV patients at Gicumbi District Hospital. By researching into this underexplored area, our purpose is to establish

a deeper understanding and potentially uncover essential insights that can inform targeted interventions and healthcare strategies tailored to this specific population.

Methods

Study Design

A hospital-based cross-sectional study was conducted among all people with HIV attending ART in the department of HIV at the Byumba District Hospital located in Gicumbi District.

Study Settings and Participants

The study was conducted at Byumba District Hospital in Gicumbi District whereas this District is located in Northern Province of Rwanda. Byumba District Hospital oversees 25 health centres; this District Hospital is located in Byumba District, Northern Province of Rwanda, which accommodates a population of 428,203 segmented into 21 administrative Sectors. As for the inclusion criteria, the study encompassed PLWH who were at least 14 years of age and had been on ART for a minimum of 6 months within the study area. Those who declined participation for any reason, and individuals with incomplete information in their medical records were also excluded.

Sample Size

We used Cochran formula to determine a sample size for this study.[34] This formula was applied in consideration of the following statistical parameters; 95% of confidence intervals ($z\alpha/_2$=1.96), 5% of statistical significance (d = 0.05), 5% non-response rate, and taking the prevalence (50%) of hypertension (p = 0.50, q = 1-p). Hence, the total sample size of 406 participants was randomly enrolled in this study from 669 HIV positive on ART who were under ART at Byumba District Hospital.

Data Collection

Data collection was performed by the general nurse under supervision of the first author of this study. In addition to that, a simple random sampling technique was used to recruit study participants during their follow-up visits; the study participants were drawn by lottery from the total patients on follow-up from their registries.

Study Variables

Dependent variable of the study is hypertension status (having hypertension according to the definition or not having hypertension). Hypertension is according to self-reported ongoing antihypertensive treatment, or systolic blood pressure (SBP ≥ 140 mmHg) and diastolic blood pressure (DBP ≥ 90 mmHg).[35] Our independent variables included socio-demographic variables (such as age, sex, religion, education level, marital status, occupation and social category,[36] behavioral variables such as smoking and alcohol use. Social category (also known as Ubudehe category) refers to a traditional classification system in Rwanda used to categorize households based on socio-economic status. This classification helps in identifying vulnerable households and allocating resources and support accordingly. The categories range from 1 to 4, with the first category representing the most economically challenged households and the fourth category representing the most prosperous ones. This system also plays a significant role in various aspects of social welfare, resource allocation, and development programs in Rwanda.[37] Smokers were defined as those who had consumed at least one cigarette or other local tobacco product within the previous 24 months before the data collection. Based on the frequency and volume of alcohol consumed during a normal drinking week, alcohol consumption was dichotomously classified as yes (for those who consume alcohol) and no (who never consume alcohol).

After at least 15 minutes of relaxation, we adopted a sitting position and used an automatic or validated oscillometer device to measure (OMRON HEM-7322U) SBP and DBP. In accordance with the 2018 ESC recommendations, three measures were made in each arm at 5-minute intervals.[35] Weight of the study participant was measured in light clothing and without shoes, and height was calculated to the nearest 0.1 cm using a stadiometer. Weight (kg)/height was used to determine the body mass index (BMI) (m^2). BMI was divided into four categories: underweight (BMI = 18.5 kg/m^2),

normal weight (18.5–24.9 kg/m^2), overweight (BMI=25-29.9 kg/m^2), and obese (BMI = 30 kg/m^2). According to the WHO 2020 guidelines, adequate physical activity is defined as 150 minutes of moderate or vigorous activity each week, or at least 75 minutes of each.[8] In our study, we used "Physical Activity Logs or Diaries" to gauge the physical activities of our research participants. These logs served as a means for participants to meticulously document their daily or weekly activities, noting the duration and intensity of each. This method enabled us to ascertain whether individuals were actively involved in physical activities (recorded as 1 = active) or not (recorded as 0 = less active). The assessment of these logs involved specific criteria: (a) the frequency of participation in physical activities, (b) the duration of each activity session, (c) the intensity level of the activities, (d) ensuring that the recorded activities aligned with the definition of physical activity (eg, exercises, sports, recreational pursuits, household chores, walking), and (e) the consistency of participants in engaging in physical activities within a predetermined timeframe (eg, weekly) to qualify as regular practitioners. Further, we categorized individuals as physically active if they met the following conditions: (a) involvement in physical activities on a minimum of 3 days per week, (b) each activity session lasting at least 20 minutes, and (c) participation in activities ranging from moderate to vigorous intensity. In addition to physical activity, diabetes was defined as having a fasting blood glucose level of 126 mg/dL (7 mmol/L)[38] or higher, or if you are currently taking diabetes medication. Clinical data such as HIV infection duration, ART duration, HIV clinical stages, and ART regimen types were collected. Respondents with viral loads of 1000 copies/mL were considered to have viral suppression, whereas viral loads of 50 copies/mL are considered undetectable Further, a self-report questionnaire was used to collect socio-demographic and behavioural variables. Clinical examinations and laboratory tests (such as viral loads, CD_4, and ART regimen) were performed. Clinical data were extracted from the medical records from HIV unit.

Statistical Analyses

The data from the field was entered into an excel sheet. The STATA version 13 was used for descriptive and analytical analyses. Descriptive statistics were used to summarize, organize sample characteristics, describe research variables and document response rate where frequency tables were presented. Cross tabulations and proportions between independent and dependent variables were performed. Bivariate logistic regression analysis was performed based on crude odds ratios (COR) to examine the significant variables of hypertension among study participants. Additionally, all statistical significant variables in bivariate logistic regression analysis were exported into multivariate logistic regression models that determined the adjusted odds ratios for the factors associated with hypertension. The significance of the findings was set at $p < 0.05$ and 95% of confidence intervals was considered.

Results

Basic Characteristics of the Study Participants

A total of 406 PLWH took part in this study. The average age of the participants was 37.91 age (SD = 2.12). A notable proportion (50.5%) of these participants fell into the age group of 40 years or younger. The sex distribution showed that the majority (52.2%, n = 212) were females, while approximately three-quarters (75.4%) were engaged in farming activities as their primary source of income. In terms of religious affiliation, a significant percentage (84.4%) identified as Christians, and more than half (56.9%) were married. Educational background analysis revealed that nearly 68% of the PLWH had received primary school education. Additionally, findings indicated that 35.9% of the participants were consumers of alcohol, 7.4% were smokers, 28.6% reported being physically inactive, and 46.1% were classified as overweight or obese. Furthermore, the study unveiled that 62.3% of the participants had been living with HIV for more than 3 years, and 67.5% had been on ART for over a year. Ultimately, the study reported a prevalence of hypertension at 22.4% (Table 1).

Prevalence and Bivariate Analysis of Factors Associated with Hypertension

Our results from the bivariate logistic regression analyses revealed significant associations between hypertension and variables including that age, BMI, smoking, alcohol use, living with diabetes and family history of hypertension. Being aged over 41 years was notably associated with an increase hypertension risk [COR = 3.29; 95% CI = 1.98–5.46]

Table 1 Descriptive Statistics of Socio-Demographic, Lifestyle and Clinical Characteristics of the Study Participants (n=406)

Variable	Frequency	Percentage
Age; Mean (standard deviation)	37.91 (SD=2.12)	
Age group		
14–40 years	205	50.5
41–62 years	201	49.5
Sex		
Female	212	52.2
Male	195	47.8
Occupation		
None	25	6.1
Business	67	16.5
Civil servant	8	2.0
Farmer	306	75.4
Religion		
Christian	343	84.4
Muslim	23	5.7
None	40	9.9
Marital status		
Single	65	16.0
Cohabiting	48	11.8
Married	231	56.9
Widowed	41	10.1
Divorced/Separated	21	5.2
Education level		
None	37	9.1
Primary	275	67.7
Secondary	85	20.9
Tertiary	9	2.2
Social category		
Category 1	111	27.3
Category 2	199	49.0
Category 3	96	23.7

(*Continued*)

Table 1 (Continued).

Variable	Frequency	Percentage
Alcohol consumers		
No	260	64.04
Yes	146	35.96
Tobacco smoking		
No	376	92.6
Yes	30	7.4
Physical activity		
Active	290	71.4
Less active	116	28.6
Nutritional status		
Underweight (<18.6 kg/m^2)	NA	NA
Normal (18.6–24.9 kg/m^2)	219	53.9
Overweight or obesity (25 and plus kg/m^2)	187	46.1
Duration living with HIV		
0–3 years	153	37.7
More than 3 years	253	62.3
ART duration		
Less than 1 year	132	32.5
1 year and above	274	67.5
Hypertension		
Yes	91	22.4
No	315	77.6

Abbreviations: NA, Not applicable since there were not data on this variable; HIV, Human immunodeficiency virus.

compared to those under 41 years. Smoking [COR = 12.24; 95% CI (5.23; 28.63)] and alcohol use [COR = 2.33; 95% CI = 1.45–3.75] were significantly associated with hypertension. Further, PLWH with overweight or obesity presented a significant association with hypertension [COR = 3.29; 95% CI = 1.98–5.46] relative to those without excess weight. Individuals with a history of diabetes were more prone to hypertension [COR = 2.1; 95% CI = 1.83–5.8] than their counterparts without such a diagnosis (Table 2).

Multivariate Logistic Regression Models for the Associated Factors of Hypertension

The findings from multivariate logistic regression models demonstrated that BMI, age, family history of hypertension, smoking, and living with diabetes were noteworthy risk factors associated with hypertension. Specifically, individuals aged 41 years and older showed significantly greater odds of hypertension in comparison to those aged between 14 and 40 years [AOR = 4.49; 95% CI = 2.45–8.21, $p < 0.001$]. Further, smokers were more likely to be hypertensive [AOR = 12.12; 95% CI = 4.48–32.74, $p < 0.001$] compared to non-smokers counterparts. Those who reported alcohol consumption were nearly six times more likely to experience hypertension [AOR = 5.5; 95% CI = 2.75–10.9, $p < 0.001$] than non-

Table 2 Prevalence of Hypertension by Socio-Demographic, Lifestyle and Clinical Characteristics and Bivariate Analysis of Factors Associated Hypertension

Variables	Total	No Hypertension		Hypertension		COR	95% CI	p-value
		N	%	N	%			
Age group								
14–40yrs	205	179	87.32	26	12.68	1		
41yrs and above	201	136	67.66	65	32.34	3.29	1.98, 5.46	<0.001***
Sex								
Male	212	164	77.36	48	22.64	1		
Female	194	151	77.84	43	22.16	0.97	0.61, 1.55	0.908
Religion								
None	40	29	72.5	11	27.5	1		
Christian	343	267	77.84	76	22.16	0.75	0.36, 1.57	0.447
Muslim	23	19	77.59	4	17.39	0.56	0.15, 2	0.368
Occupation								
None	25	19	76	6	24	1		
Business	67	49	73.13	18	26.87	1.16	0.4, 3.37	0.781
Civil servant	8	7	87.5	1	12.5	0.45	0.05, 4.46	0.497
Farmer	306	240	78.34	66	21.57	0.87	0.33, 2.27	0.777
Education								
None	37	31	83.78	6	16.22	1		
Primary	275	212	77.09	63	22.91	1.53	0.61, 3.85	0.36
Secondary	85	64	75.29	21	24.71	1.69	0.62, 4.62	0.303
Tertiary	9	8	88.89	1	11.11	0.65	0.07, 6.16	0.704
Marital status								
Single	65	50	76.92	15	23.08	1		
Cohabiting	48	40	83.33	8	16.67	0.67	0.26, 1.73	0.405
Married	231	179	77.49	52	22.51	0.97	0.50, 1.86	0.923
Widowed	41	30	73.17	11	26.83	1.22	0.5, 3.01	0.662
Divorced/Separated	21	16	76.19	5	23.81	1.04	0.33, 3.32	0.945
Social category								
Category 1	111	82	73.87	29	26.13	1		
Category 2	199	154	77.39	45	22.61	0.83	0.48, 1.42	0.487
Category 3	96	79	82.29	17	17.71	0.61	0.31, 1.19	0.148

(*Continued*)

Table 2 (Continued).

Variables	Total	No Hypertension		Hypertension		COR	95% CI	p-value
		N	%	N	%			
Alcohol consumption								
No	260	216	83.08	44	16.92			
Yes	146	99	67.81	47	32.19	2.33	1.45, 3.75	<0.001***
Tobacco use or smoking								
No	376	307	81.65	69	18.35	1		
Yes	30	8	26.67	22	73.33	12.24	5.23, 28.63	<0.001***
Physical activity								
Active	291	221	75.95	70	24.05	1		
Less active	115	94	81.74	21	18.26	3.08	1.03, 9.22	0.021*
Family history of hypertension								
No	395	310	78.48	85	21.52	1		
Yes	11	5	45.54	6	54.55	4.38	1.3, 14.69	0.017*
CD_4 cell count (copies/mL)								
<200 copies/mL	103	89	86.41	14	13.59	1		
200–400 copies/mL	129	97	75.19	32	24.81	0.84	0.71, 0.99	0.021*
>400 copies/mL	168	129	76.79	39	23.21	0.62	0.43, 0.88	0.013*
Viral loads (copies/mL)								
Less than 1000	260	226	87	34	13	1		
More than 1000	146	109	74.7	37	25.3	2.32	0.12, 4.81	0.062
ART regimen								
TDF+3TC+EFV	102	81	79.41	21	1			
TDF+3TC	80	57	71.25	23	28.75	1.01	0.95, 1.08	0.054
ABC+3TC	79	67	84.81	12	15.19	0.99	0.92, 1.06	0.082
AZT+3TC+NVP	98	76	77.55	22	22.45	0.84	0.67–1.05	0.056
AZT+3TC	47	34	72.34	13	27.66	1.03	0.95, 1.13	0.124
Family history of diabetes								
No	393	311	79.13	82	20.87	1		
Yes	13	4	30.77	9	69.23	8.53	2.56, 28.41	<0.001***
Being diabetic								
No	400	314	78.5	86	21.5	1		
Yes	6	1	16.67	5	83.33	2.1	1.83, 5.8	0.008**

(*Continued*)

Table 2 (Continued).

Variables	Total	No Hypertension		Hypertension		COR	95% CI	p-value
		N	%	N	%			
Duration living with HIV								
0–3 years	153	120	78.43	33	58			
>3 years	253	195	77.08	21.57	22.92	1.08	0.67,1.76	0.751
ART duration								
Less than 1 year	132	100	75.76	32	24.24	1		
More than 1 year	274	215	78.47	59	21.53	0.86	0.52,1.4	0.54
BMI								
Underweight	NA	NA	NA	NA	NA	NA		
Normal	219	179	81.74	40	18.26	1		
Overweight & obese	187	136	72.73	51	27.27	1.68	1.05,2.69	0.031*

Notes: *Significant at 5%, **Significant at 1%; ***Significant at 0.1%; Social category: This research solely enrolled individuals classified within the first (the poorest people) to third social categories (poor people) due to the absence of participants from higher categories in the ART sessions. Nonetheless, it's worth noting that the study area predominantly comprises people falling within these initial three social categories.

Abbreviations: NA, Not applicable since there were not data on this variable; TDF, Tenofovir; EFV, Efavirenz; ABC, Abacavir; 3TC, Lamivudine; EFV, Efavirenz; NVP, Nevirapine, AZT, Zidovudine.

consumers of alcohol. Similarly, individuals with a family history of hypertension were at higher likelihoods to be hypertensive [AOR = 4.28; 95% CI = 1.01–18.13, p = 0.049] than those without such a history. Additionally, diabetics were nearly 6 times more likely to experience hypertension [AOR = 4.50; 95% CI = 2.55–7.95, p = 0.018] than their counterparts. Lastly, PLWH with overweight or obesity presented almost more likelihoods to be hypertensive [AOR = 1.91; 95% CI = 1.11–3.3, p = 0.020] compared to those with normal BMI. Regarding clinical data, the results on CD_4 indicated that patients with >400 copies/mL [AOR = 0.84; 95% CI = 0.71–0.99, p < 0.001] and 200–400 copies/mL [AOR = 0.62; 95% CI = 0.43–0.89, p < 0.001] had lower likelihoods of hypertension compared to those with <200 copies/mL. However, our findings showed that hypertension was not associated with VL and ART regimen (Table 3).

Discussion

The prevalence of hypertension was 22.4% which is higher than the prevalence reported in Burundi, Tanzania, Uganda, among individuals living with HIV.[5,7,38,39] The prevalence was significantly highly prevalent in men than in females. Further, our results indicated that the prevalence of hypertension is higher among people aged more than 41 years. These results are comparable to the previous documented a high prevalence of hypertension among HIV positive patient.[40–42] These results highlight the disparity in the magnitude of hypertension among persons living with HIV in SSA countries which may associated with a number of reasons such as genetic and socio-economic conditions, duration of disease and clinical outcomes, behavioural issues, types of therapies received and study settings. These results collaborated with the prior studies.[7,22,43]

Among the participants whose blood pressure was measured before the survey, approximately 15% exhibited elevated hypertension levels, falling within a risky weight range. Notably, individuals categorized as overweight or obese demonstrated a higher likelihood of hypertension in comparison to those with a normal BMI. These findings are consistent with earlier research that reported that individuals with a obesity or overweight were more likely to be hypertensive[26,44] whereas those with underweight were a lower risk to experience hypertension compared those with normal weight.[7,26,45] These outcomes align with prior studies that have also highlighted an increased hypertension risk among HIV patients who are overweight or obese when contrasted with those with a normal BMI.[46,47] Moreover, the

Table 3 Multivariate Analysis for the Associated Factors of Hypertension in PLWH

Variables	Multiple Regression Models Analysis		
	AOR	**95% Confidence Internals**	**p-value**
Socio-demographic characteristics			
Age group			
14–40 years	1		
41 years and above	4.49	2.45, 8.21	<0.001***
Alcohol consumption			
No	1		
Yes	5.5	2.75, 10.9	<0.001***
Tobacco smoking			
No	1		
Yes	12.12	4.48, 32.74	<0.001***
Family history of hypertension			
No	1		
Yes	4.28	1.01, 18.13	0.049*
Family history of diabetes			
No	1		
Yes	12.02	2.83, 51.10	0.052
Diabetics			
No	1		
Yes	4.50	2.55, 7.95	0.018*
Physical activity			
Active	1		
Less active	3.91	1.12, 13.62	<0.01**
CD_4 + Counts gain (Cells/mL)			
<200 copies/mL	1		
200–400 copies/mL	0.62	0.43, 0.89	<0.001***
>400 copies/mL	0.84	0.71, 0.99	<0.001***
BMI			
Underweight (<18.6kg/m^2)	NA		
Normal (18.6–24.9 kg/m^2)	1		
Overweight and obesity (25 and plus kg/m^2)	1.91	1.11, 3.3	0.02*

Notes: *Significant at 5%, **Significant at 1%; ***Significant at 0.1%.
Abbreviations: NA, Not applicable since there were not data on this variable; AOR, Adjusted odds ratio; BMI, Body Mass Index; COR, Crude Odd ratio; AOR, Adjusted odds ratio; CI, Confidence Intervals.

prevalence of hypertension was significantly higher among participants aged 40 and above. These results were in concurrence with the conclusions drawn by several other researchers.[29,48] This implies that individuals aged 41 or older greater likelihoods of developing hypertension than those who were younger, aligning with the observations of other researchers who also noted a substantial rise in blood pressure starting from the age of 40.[43,49]

Our findings indicated that smokers were at a higher likelihoods developing hypertension than the non-smokers. These results are consistent with previous research,[41,50,51] although they differ from the findings of a study conducted in Burundi.[7] Further, our results revealed that participants with diabetes had greater odds to be hypertensive than their counterparts. These results are in alignment with findings from earlier studies.[7,48,52] Interestingly, our study did not identify a noteworthy association between hypertension and factors such as gender, education, marital status, and social category. Nevertheless, these factors have been previously published as risk factors for hypertension.[23,41] It is plausible that the absence of such an association could be attributed to the limitations of a relatively small sample size and the nature of our cross-sectional institutional study. While prior studies reported that duration under ART contribute as a factor of hypertension,[53] our study found no association between duration and hypertension.

Our findings uncovered a surprising inverse relationship between CD_4 counts and hypertension among our HIV patient cohort, wherein individuals with CD_4 counts exceeding 400 copies/mL and those within the range of 200–400 copies/mL exhibited a notably reduced likelihood of hypertension compared to those with counts below 200 copies/mL. These results align with previous studies[54] that have suggested a potential link between higher CD_4 counts and a diminished risk of hypertension. Additionally, our analysis of VL revealed no significant association with hypertension, contrary to some prior research.[55] Despite existing literature proposing ART regimens as potential contributors to hypertension among HIV patients,[56] our study did not establish a significant correlation between specific ART regimens and hypertension. Understanding these divergent trends between VL and CD_4 counts concerning hypertension in HIV patients could benefit from an exploration of existing literature focused on the intricate interplay between immune status, VL, and cardiovascular health outcomes within similar populations. Comparatively, exploring studies that examine the influence of VL and varied ART strategies on hypertension in HIV populations might offer additional perspectives or confirmatory evidence to contextualize our findings.

Strengths and Limitations

This study has a significant strength due to its substantial sample size and its innovative nature within the health facility from the rural area. Notably, our research derives its conclusions from a sample that is representative of individuals aged between 14 and 41 years in the study area. While these strengths are commendable, it is essential to acknowledge certain limitations that warrant discussion. Firstly, the authors could not generalise the findings to all people with HIV in Rwanda because it was a hospital-based study. Secondly, a cross-sectional design of this study impedes its capacity to establish causal relationships between hypertension and its associated factors. Thirdly, certain crucial factors such as socio-demographic variables (eg, place of residence), comorbidities, clinical aspects (such as stroke, viral loads, ART regimen, CD_4 counts), psychological influences, socio-cultural factors, and nutritional considerations were not included in our data collection. Lastly, the limitation lies in the small count of participants below the age of 40. This resulted in the formation of two age brackets: one encompassing 14 to 40-year-olds as adolescents and young adults, and the other involving individuals above 40 years old categorized as adults. This grouping of adolescents and adults within the first age group is conceded as a limitation.

Conclusions

Our study constitutes the initial documentation of a significantly heightened occurrence of hypertension among individuals living with HIV. Our findings have illuminated the jeopardy that hypertension imposes upon HIV-positive individuals in the investigated region. The results we have derived signify that hypertension stands as a formidable public health concern for PLWH within the rural facility where our study was conducted. We have founded that age, smoking, alcohol consumption, smoking, overweight and obesity, as well as living with diabetes, emerge as pivotal factors contributing to the prevalence of hypertension in this population. These findings accentuate the importance for the integration of hypertension management into the routine care provided to individuals with HIV. Such integration holds

the potential to mitigate adverse ramifications and enhance cardiovascular well-being among those undergoing ART. Besides, longitudinal studies are recommended to explore how incidence of hypertension changes over-time, and examine causality of hypertension and identify additional factors of hypertension. There is a need of the research on the impact of specific ART regimens on the development, management of hypertension. This could involve investigating whether certain types of antiretroviral medications or combinations are more strongly linked to hypertension, as well as considering how the duration of ART might affect hypertension. This will provide valuable insights for healthcare providers in tailoring treatment plans and interventions for HIV-positive patients with hypertension.

Data Sharing Statement

The datasets used and/or analysed during this study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Informed consent was obtained from all participants involved in this study. Participants aged 18 years or older provided both oral and written informed consent forms before their inclusion in the research. For participants below 18 years old, their assent to participate to the study was obtained alongside consent forms from their caregivers. Ethics approval for this study was granted by the Institutional Review Board of the College of Medicine and Health Sciences at the University of Rwanda (reference number: 378/CMHS IRB/2018). The study adhered to the principles outlined in the Helsinki Declaration. Further, authorization for the study was also acquired from the Ministry of Health through Rwanda Biomedical Center (RBC), which facilitated the provision of informed consent forms on behalf of the participants. Prior to data collection, the researchers provided a comprehensive explanation of the study's objectives, potential benefits, and the selection criteria to the participants. They were explicitly informed of their right to withdraw from the research at any point without facing any consequences. Throughout the data collection process, strict adherence to confidentiality measures was ensured. All data collection procedures were conducted anonymously and in line with ethical standards.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

Authors declare that they have no competing interests.

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