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HIV-hypertension treatment outcomes among adults on antiretroviral therapy in two states in Northern and Southern Nigeria: a cross-sectional design approach

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Abstract

Background: The combined effect of the aging human immunodeficiency virus (HIV) population, HIV's natural progression, and HIV drugs have great implications for comorbidity burden and hypertension control among people living with HIV (PLHIV).

Objectives: This study assessed hypertension burden, treatment outcomes, and treatment outcome predictors among PLHIV in Nigeria.

Design: Cross-sectional design.

Methods: A cross-sectional study of 2613 adult PLHIV who initiated antiretroviral therapy (ART) between 2004 and 2020 in two HIV clinics in Northern and Southern Nigeria. Study outcomes were: (1) controlled blood pressure defined as two consecutive blood pressure (BP) measurements of $<$140/90 mmHg (Joint National Committee guideline (JNC) 7) on the interview day in previously diagnosed hypertensive participants; and (2) HIV viral suppression defined as recent viral load count of $<$1000 copies/ml in a hypertensive participant. Data were analyzed using Statistical Package of Social Sciences IBM version 23. Univariate and multivariate logistic regression was done to ascertain factors associated with the study outcomes at $p < 0.05$.

Result: The mean age of respondents at the point of the study was 45.3 ± 9.8 years. Most of the participants were female, 1940 (74.2%), on a dolutegravir-based therapy, 2433 (93.2%). About 452 (17.3%) of the participants had clinically diagnosed hypertension. Of those diagnosed hypertensives, 443 (98.0%) were on antihypertensive drugs. About 407 (90.0%) and 229 (51.7%) of the hypertensive PLHIV had HIV viral suppression and controlled hypertension respectively. Factors associated with controlled hypertension were age at ART initiation (adjusted odds ratio (AOR): 0.96, 95% CI: 0.94–0.98), use of thiazide only antihypertensive (AOR: 1.91, 95% CI: 1.73–3.24, Ref: calcium channel blocker only) and thiazide-calcium channel blocker combination (AOR: 2.19, 95% CI: 1.05–4.58). No hypertension comorbidity-related factors were found to be associated with HIV viral suppression.

Conclusion: There is suboptimal hypertension control among hypertensive PLHIV especially those on non-thiazide-based antihypertensive drugs. Close monitoring should be given to hypertension management in PLHIV.

Keywords: hypertension, hypertension treatment outcome, hypertension control, PLHIV

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Introduction

The combined intervention effect of early detection of human immunodeficiency virus and early initiation of HIV-positive people on highly effective antiretroviral therapy (ART) has helped in reducing morbidity and prolonging life among people living with HIV (PLHIV).[1,2] Recent trend analysis and projection show a substantial increase in the proportion of PLHIV aged 50 years and above from 2000 to date, with higher projected absolute numbers in Sub-Saharan Africa due to their relatively high HIV burden.[3] This aging phenomenon coupled with the prolonged period of HIV infection and antiretroviral drug utilization is increasing the array of health complications in PLHIV. Recent epidemiological trend analysis shows an increased prevalence of cardiovascular disease risk factors such as obesity, dyslipidemia, insulin resistance, diabetes, and hypertension among PLHIV, with hypertension being the most implicated.[4,5] Results of a systematic review showed an estimated global hypertension prevalence of 25.2% among PLHIV.[6] In Nigeria, the prevalence varied across geopolitical regions, with a prevalence range of 12.3%–50.3%.[7,8] However, it is noteworthy that there was a substantial increase in the prevalence of hypertension among PLHIV from about 20% in 2002 to 35% in 2016 in South East Nigeria.[4] These HIV co-morbidities are increasing polypharmacy among PLHIV. A systematic review on the management of polypharmacy among PLHIV reported a polypharmacy prevalence range of 9%–91% and a severe polypharmacy prevalence range of 2.6%–19.5%.[9] The drugs reported in this sub-population were mostly antihypertensives, statins, antithrombotic agents, corticosteroids, divalent cations, and antacids.[9] This emerging polypharmacy among PLHIV has great implications for drug selection, adherence, and the overall treatment outcome of both disease entities due to the possible counter-interactions of the disease entities, their drug–drug interaction, and due to the increased pill burden.

Although few studies done among hypertensive PLHIV have documented good HIV viral load suppression in the population within the range of 90%–98%, none of them compared HIV viral control between hypertensive and non-hypertensive PLHIV for relative advantage and also examined the effect of various antihypertensive therapy on HIV viral suppression.[10,11] Furthermore, studies have reported poorer hypertension control among PLHIV globally, with a pooled global hypertension control prevalence of 13.4% (95% CI: 4.7%–22.1%) among PLHIV when compared to the general population of about 18%–23% prevalence rate.[12,13] In Sub-Saharan Africa (SSA), the median hypertension control prevalence among PLHIV was estimated as 9.1%,[12] with a range of 0% in Tanzania,[14] 24.3% in Malawi and Uganda,[15,16] and 39.8% in Ethiopia.[17] The prevalence is also worse in PLHIV compared to the general population in SSA.[17] In Nigeria, there are few published pieces of literature on hypertension control among PLHIV. Findings from a few reports showed that the management of hypertension among PLHIV also remains unsatisfactory. A study conducted in a Teaching Hospital in Uyo Nigeria, showed a hypertension control prevalence rate of 24.4% among PLHIV, with the majority of the participants having uncontrolled hypertension.[18] Of note was that the majority of the PLHIV diagnosed with hypertension were already on ART before being diagnosed with hypertension. Reported risk factors for uncontrolled hypertension in PLHIV range from poor awareness about hypertension screening and management to poor hypertension care-seeking behavior, and poor adherence to prescribed blood pressure-lowering treatment.[18,19] In this study, we assessed bidirectional treatment outcomes among clinically diagnosed hypertensive PLHIV on ART and their associated factors.

Methodology

Study design

A cross-sectional study of 2613 adult PLHIV (⩾18 years) who initiated ART between 2004 and 2020 in two HIV clinics in Northern and Southern Nigeria, to assess for hypertension comorbidity burden and bidirectional treatment outcome and associated factors among PLHIV diagnosed with hypertension.

Sample size and sampling technique

A purposive sampling technique was employed. All adult PLHIV (⩾18 years) who initiated ART between 2004 and 2020 in the two HIV clinics were considered for recruitment.

Inclusion criteria

Adult PLHIV (⩾18 years) who initiated ART between 2004 and 2020 in two HIV clinics.

Exclusion criteria

- Participants who could not be reached during the 8 months of data collection for confirmation of hypertension status.
- Patients who reported that they had been previously diagnosed of hypertension but whose hypertension diagnosis could not be confirmed or cross-referenced.
- Acutely ill participants.
- Non-consented participants.

Research setting

The study was conducted in Adeoyo Maternity Hospital, Ibadan, Oyo State, Nigeria, and Our Lady of Apostle (OLA) Hospital, Jos, Plateau State, Nigeria. The two clinics are part of the APIN Public Health Initiatives-supported facilities for Improved HIV service delivery under the Centers for Disease Control iCARES grant in Nigeria. Adeoyo Maternity Hospital is a public secondary health facility, while OLA hospital is a private health facility. The facilities serve as referral centers for the provision of secondary care for most primary health facilities in their senatorial districts. In both clinics, non-communicable disease management, including hypertension, has not been integrated into ART care. However, blood pressure (BP) measurements are occasionally done at the nursing station, and identified patients with suspected high BP are referred to the outpatient or general medical clinics for treatment and follow-up. Furthermore, there is incomplete documentation of BP measurements in the electronic medical records of both clinics. However, a majority of the patients had baseline BP measurements at ART initiation.

Adeoyo Maternity Hospital is situated in Oyo state in the South-Western region of the country. According to the 2006 National Census, the State has a population of 5,580,894 with a population projection of 7,976,100 by the end of the year 2021.[20] The prevalence of HIV in Oyo State was 0.9%,[21] while hypertension prevalence ranges between 33% and 39% among adults.[22,23] Similarly, OLA hospital is situated in Plateau state, one of the North Central states with a population of 3,206,531 according to the 2006 census and a projected population of 4,717,300 by the end of 2021.[24] According to the Nigeria AIDS Indicator and Impact Survey 2018, the prevalence of HIV in Plateau State is 1.5%[25] while the prevalence of hypertension in the state ranges from about 22.2% to 32% for adults.[26,27]

Study participants recruitment

Study participants were adult PLHIV, 18 years and above, who were enrolled in HIV care between 2004 and 2020. Patients who were acutely ill, frail, or patients diagnosed with hypertension during the study period but whose hypertension diagnosis could not be confirmed or cross-referenced, were excluded from the study.

Data were collected over a period of 8 months. We line-listed eligible participants from the electronic medical records of the ART clinics of both hospitals and booked appointments with them for interviews and measurement of BP. On the interview day, verbal reports of previous hypertension diagnoses were elicited. Patients who confirmed previous diagnoses were followed up at the clinics where they were receiving hypertension care for records cross-referencing, provided the clinic is within the hospital premises or within a 5 km radius of the study site. Patients who were receiving hypertension care in hospitals outside a 5 km radius were also included, provided they had home-based cards or exercise books for cross-referencing their verbal reports. Participants who were confirmed hypertensive through a verbal report and cross-referencing had two consecutive measurements of their BP, 30 min apart on the interview day to know their current BP status.

Study instrument and variables, and data collection procedure

Data was collected using a project-developed electronic questionnaire that elicited information on patient demographic characteristics, HIV care history, and verbal reports of previous diagnoses of hypertension or diabetes. The electronic tool was developed using a kobo-collect application ensuring end-to-end encryption of transmitted data. BP was assessed using an Accoson mercury sphygmomanometer while the patient was in a sitting position and relaxed state. The systolic and diastolic BP values were determined using the initial and fifth Korotkoff sounds, respectively. Two consecutive measurements were taken for each patient, using both arms of the patient. When there were differences in the BP, the

measurements from the arm with the higher BP were taken.

Study outcomes included (1) hypertension prevalence among study participants, (2) HIV viral suppression, and (3) good hypertension control among confirmed hypertensive PLHIV on antihypertensive therapy. Hypertension in this study was defined as clinically diagnosed hypertension as reported by participants and confirmed by study nurses through cross-referencing of hypertension care records, while good hypertension treatment outcome (controlled BP), was defined as two consecutive blood pressure measurements of <140/90 mmHg (Joint National Committee guideline (JNC) 7) on the interview day in previously diagnosed hypertensive participant. This was further disaggregated into grade 1 and 2 for descriptive purposes. Grade 1 was defined as BP 140–159/90–99 mmHg and Grade 2 as BP ⩾ 160/100 and (2) good HIV treatment outcome (HIV viral suppression), defined as recent viral load count of <1000 copies/ml in a hypertensive participant.

Data management and analysis

Data was collected by nurses and Data Entry Clerks under the supervision of site co-investigators. Using questionnaire forms that elicited information on participants' backgrounds, clinical history, and non-communicable disease (NCD) occurrence. The research assistants also conducted verbal interviews and record reviews of HIV and chronic disease clinic records. End-to-end encryption was done to secure electronic data during transmission. Data cleaning and analysis were done using Statistical Package for Social Sciences (SPSS) IBM version 23. Descriptive findings were presented using tables. Univariate and multivariable logistic regression was done to ascertain factors associated with the study outcomes at p value of less than 0.05. The reporting of this study conforms to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[28]

Result

Participant's background characteristics

A total of 2650 participants were surveyed, with a response rate of 98% (2613 complete responses) across key exposure and outcome variables. The mean age of respondents at the point of the study was 45.3 ± 9.8 years and 40.2 ± 10.1 years at the participants' ART initiation. Most of the participants were female, 1940 (74.2%), on a dolutegravir (DTG)-based therapy, 2433 (93.2%), without any history of tuberculosis, 2374 (90.9%) or other opportunistic infections, 2527 (96.7%). Further analysis shows a statistically significant difference in age ($p = 0.02$), sex ($p < 0.01$), history of diabetes ($p < 0.01$), history of opportunistic infections ($p < 0.01$), and tuberculosis ($p < 0.01$) between participants with and without hypertension Table 1.

Prevalence of HIV-hypertension comorbidity

About 452 and 23 of the participants had clinically diagnosed hypertension and diabetes mellitus, giving a prevalence rate of 17.3% and 0.9%, respectively. The majority of those diagnosed

Table 1. Participants' background characteristics and HIV care history.

Variable (s)	Hypertension status		Total (2613)	*p* Value
	Not Hypertensive (2161)	Hypertensive (452)		
Respondent's gender				
Male	512 (23.7)	161 (35.6)	673 (25.8)	<0.01
Female	1649 (76.3)	291 (64.4)	1940 (74.2)	
Current ART regimen				
DTG-Based Therapy	2016 (93.3)	417 (92.3)	2433 (93.2)	0.39
Others	145 (6.7)	35 (7.7)	180 (6.8)	

(Continued)

Table 1. (Continued)

Variable (s)	Hypertension status		Total (2613)	*p* Value
	Not Hypertensive (2161)	Hypertensive (452)		
Any previous history of TB diagnosis in the past?				
No	1994 (92.3)	380 (84.1)	2374 (90.9)	<0.01
Yes	167 (7.7)	72 (15.9)	239 (9.1)	
Any history of diagnosis of any other opportunistic infection in the past?				
No	2106 (97.5)	421 (93.1)	2527 (96.7)	<0.01
Yes	55 (2.5)	31 (6.9)	86 (3.3)	
Is the patient on clo-trimoxazole (Septrin) therapy?				
No	1417 (65.6)	173 (38.3)	1590 (60.8)	<0.01
Yes	744 (34.4)	279 (61.7)	1023 (39.2)	
Diabetes status				
No	2148 (99.4)	442 (97.8)	2590 (99.1)	<0.01
Yes	13 (0.6)	10 (2.2)	23 (0.9)	
Mean current age of respondents (Years)				
Mean	44.1	51.1	45.3	0.02
SD	9.4	9.7	9.8	
Mean age at ART initiation (Years) for HIV+ participants				
Mean	35.5	9.6	40.2	0.05
SD	40.4	10	10.1	
Median CD4 at ART initiation (cells/ml)				
Median	254.0	242.0	252.0	0.14
IQR	138.0–413.0	122.0–379.0	135.0–407.0	
Current antihypertensive drug				
Calcium channel blockers only		83 (18.3)		
Thiazide only		263 (58.2)		
Thiazide plus Calcium channel blocker		50 (11.1)		
Others		28 (6.2)		
Don't Know		19 (4.2)		
Not on any drug		9 (0.2)		
Mean number of years on antihypertensive				
Mean		6.8		
SD		4.5		

ART, antiretroviral therapy; DTG, dolutegravir.

Table 2. HIV and hypertension treatment outcomes among participants.

Variable(s)	Frequency	%
HIV viral suppression among hypertensive participants		
Virally suppressed	407	90.0
Virally unsuppressed	45	10.0
Total	452	100.0
Hypertension treatment outcome		
Controlled BP	229	51.7
Uncontrolled BP	214	48.3
Total	443	100.0
Disaggregation of hypertension treatment outcome		
Normal	75	16.9
Pre-Hypertension	154	34.8
Grade 1 Hypertension	105	23.7
Grade 2 Hypertension	109	24.6
Total	443	100.0

were on one form of known antihypertensive drugs, 443 (98.0%), with thiazide only, 263 (58.2%) and calcium channel blocker only, 83 (18.3%), being the most prevalent antihypertensive drugs. The mean number of years on antihypertensive was 6.8 ± 4.5 years to interview day Table 1.

HIV and hypertension treatment outcome among participants

Of the 452 PLHIV that were hypertensive, 407 (90.0%) of them were HIV virally suppressed, and 229 (51.7%) had controlled BP, with two consecutive BP measurements on interview day (blood pressure $<$ 140/90 mmHg). Of the 214 participants with uncontrolled BP, 105 (49.1%) had grade 1 hypertension, and 109 (50.9%) had grade 2 hypertension Table 2.

Factors associated with controlled hypertension among hypertensive PLHIV

At the univariate level, participants on thiazide only [crude odd ratio (COR); 2.01, 95% CI: 1.21–3.35] and thiazide-calcium channel blocker combinations [COR: 2.25, 95% CI: 1.09–4.63] had more than twice the odds of having controlled BP compared to those on calcium channel blockers only. Furthermore, at the univariate level, participants who commenced ART in middle age (40–59 years) and old age ($\geqslant$60 years) have 51% and 75% respectively lower odds of having controlled BP compared to those initiated at a young age. Similarly, participants on other antihypertensives such as angiotensin-converting enzyme inhibitors (ACE Inhibitors) and Aldomet have 75% lower odds of having BP control when compared with those on calcium channel blockers only. Factors that were observed to be significantly associated with participants' BP control after controlling for confounders were age at ART initiation [Middle age: adjusted odd ratio (AOR); 0.53, 95% CI: 0.34–0.81, Ref: Young age], and the use of antihypertensive drugs like thiazide only [AOR: 1.93, 95% CI: 1.12–3.30] and thiazide-calcium channel blocker combination [AOR: 1.99, 95% CI: 1.00–4.22] Table 3.

Factors associated with HIV viral suppression among hypertensive PLHIV

No hypertension comorbidity-related factors were found to be associated with viral suppression among hypertensive PLHIV in a logistic regression model at univariate and multivariate levels Table 4.

Discussion

Hypertension comorbidity burden

This study presents data on the bidirectional treatment outcomes among PLHIV on ART with clinically diagnosed hypertension, as well as the factors associated with the treatment outcomes. We found a prevalence rate of 17.3% for clinically diagnosed hypertension among PLHIV. This is similar to 16.0% and 17.0% prevalence rates in two related studies among PLHIV in Lagos and Kebbi States respectively.[29,30] While the Kebbi study was done among Antiretrovital-experienced PLHIV similar to our study, the Lagos study was done among the ARV naïve participants. Other reported prevalences of hypertension among PLHIV across states in Nigeria were higher and varied between 20.3% and 50.2%.[8,27,31] Of note is that a similar study that reported lower

Table 3. Factors associated with good hypertension treatment outcome (controlled blood pressure) among the participants.

Variables	*n*	COR (95% CI)	AOR (95% CI)
Age at ART initiation			
<40 years	55	1	1
40–59 years	305	0.49 (0.33–0.73)	0.53 (0.34–0.81)
60 years and above	92	0.25 (0.09–0.75)	0.35 (0.11–1.08)
Gender			
Male	161	1	
Female	291	1.28 (0.86–1.88)	
Current ART regimen			
Dolutegravir-based therapy	417	1	
Others	35	0.99 (0.50–2.00)	
Any previous hx of TB in the past?			
No	380	1	
Yes	72	1.25 (0.75–2.08)	
Any hx of opportunistic infections?			
No	421	1	
Yes	31	1.67 (0.78–3.60)	
Is the patient on clo-trimoxazole?			
No	173	1	
Yes	**279**	***1.85 (1.25–2.73)**	1.27 (0.81–1.98)
Diabetes Mellitus Comorbidity			
No	442	1	
Yes	10	1.57 (0.37–6.65)	
Current Hypertensive therapy			
Calcium channel blockers only	83	1	1
Thiazide Only	**263**	***2.01 (1.21–3.35)**	***1.93 (1.12–3.30)**
Thiazide and Calcium Channel blocker	**50**	***2.25 (1.09–4.63)**	***1.99 (1.00–4.22)**
Others	**28**	***0.25 (0.08–0.79)**	***0.27 (0.08–0.85)**
Number of years on antihypertensive drugs	452	1.03 (0.99–1.08)	

AOR, adjusted odds ratio; COR, crude odd ratio.
Bold indicates estimates that are statistically significant at $p < 0.05$.

prevalence like ours utilized self-reported clinically diagnosed hypertension[18] which might be subject to recall bias. Furthermore, the studies did a recall of hypertension occurrence over a period of years which might include a mix of hypertension occurrence when the national

Table 4. Hypertension comorbidity-related factors associated with HIV viral suppression.

Variable(s)	*n*	COR (95% CI)	AOR (95% CI)
Hypertensive			
No	452	1	
Yes	2161	1.35 (0.97–1.89)	
Current Hypertensive regimen (if hypertensive)			
Calcium Channel block only	83	1	1
Thiazide only	263	0.81 (0.34–1.92)	1.79 (0.33–1.91)
Thiazide and Calcium channel blocker	50	0.57 (0.19–1.72)	0.56 (0.19–1.71)
Others	28	0.0	0.0
Number of years on antihypertensive drug	452	0.99 (0.93–1.07)	1.01 (0.93–1.09)

AOR, adjusted odds ratio; COR, crude odd ratio.

program was not using DTG-based therapy and since 2018 when patients were switched to DTG-based therapy. However recent studies that utilized a cross-sectional approach with clinic BP measurement for incident hypertension diagnosis reported higher hypertension prevalence.[8,27]

Hypertension control among hypertensive PLHIV

Furthermore, our study also demonstrated a suboptimal BP control rate of 51.7% among hypertensive PLHIV. This corroborates findings from previous studies that also reported suboptimal BP control rates of <40% among hypertensive PLHIV.[12–18,32] The observed low rate of controlled blood pressure among PLHIV may be related to poor adherence to antihypertensive medications due to poor availability and affordability of such medicines as documented in the literature.[33] A research conducted in Jos also demonstrated a high cost of antihypertensive medicines when compared with international reference prices.[34] Compared to ART drugs that are accessed freely due to very efficient supply chain systems largely funded by international donors, antihypertensive medications are largely accessed in Nigeria via out-of-pocket payment. Pill burden due to polypharmacy for the management of HIV-Hypertension comorbidity may also contribute to poor adherence to antihypertensive medications among PLHIV, thus, resulting in suboptimal BP control. Our finding necessitates further research into medication adherence among hypertensive PLHIV to gain deeper insight into poor hypertension treatment outcomes among PLHIV and required interventions.

Factors associated with controlled hypertension

We also found that hypertension control worsened with increasing age at ART initiation. While there is a paucity of studies that evaluate the association between age at ART initiation and hypertension control, there is evidence in the literature that reveals that early ART initiation and longer duration of ART increases the risk for early NCD occurrence, thereby increasing the risk of polypharmacy and drug interaction that might have consequences on NCD treatment outcome including hypertension.[35,36] Additionally, our study demonstrated that when compared with other antihypertensive regimens such as angiotensin-converting enzyme inhibitors (ACEIs) and calcium channel blockers only, thiazide-based antihypertensive medicines offered better hypertension control among PLHIV. This finding is somewhat consistent with a study that reported the BP-lowering ability of thiazide as an important mediator for a lower incidence of cardiovascular disease (CVD) complications among hypertensive PLHIV on thiazide or thiazide-like diuretics as against PLHIVs on ACEIs or angiotensin receptor blockers in hypertensive PLHIV.[37] Noteworthy is that this study is limited in assessing the baseline hypertension grade for each antihypertensive regimen before drug initiation. This

might vary across regimens and might be responsible for better treatment outcomes observed for some regimens. In addition, the majority of the respondents with hypertension were on a monotherapy antihypertensive regimen contrary to international recommendations on the use of a thiazide-based combination regimen as a first-line regimen in black hypertensive PLHIV.[38] This may also have contributed to the poor hypertension control among PLHIV observed in this study. Further research is needed to dive deeper into the comparison of hypertension control between antihypertensive regimens among PLHIV in Nigeria.

HIV treatment outcome among hypertensive PLHIV

There was a very good viral suppression rate of 90% among hypertensive PLHIV, which is higher than previously reported viral suppression rates of 74.7% and 85.8% among hypertensive PLHIV.[32,39] We, however, found no significant association between hypertension comorbidity-related factors and HIV viral suppression among hypertensive PLHIV.

Our study has some limitations. First, we did not investigate the level of adherence to antihypertensive medicines among PLHIV to determine its impact on hypertension control, and this might vary across the different antihypertensive regimens prescribed for clients. Furthermore, our study estimated the prevalence of clinically confirmed hypertension, incident hypertension at the point of enrollment was not assessed. This might have contributed to the relatively low hypertension prevalence in the study. In addition, because the study relied on the historical demographic and laboratory clinical data of patients at ART enrollment, we were not able to control all confounders in this study. We recommend that future studies examine the effect of confounders such as socio-economic status, lipid abnormalities, and lifestyle factors, in this relationship.

Conclusion

In conclusion, this study set out to evaluate the bidirectional treatment outcomes in PLHIV with HIV-Hypertension comorbidity and the associated factors. We found optimal viral load suppression among hypertensive PLHIV, however, only 51.7% of PLHIV with hypertension had controlled BP, with age at ART initiation and antihypertensive regimen being significantly associated with BP control. The findings from this study necessitate the design, implementation, and reinforcement of interventions to tackle suboptimal BP control among PLHIV. More specifically, policy intervention and multi-level stakeholder commitments are required to strengthen and institutionalize integrated services for the control of non-communicable diseases, particularly hypertension among PLHIV. This is particularly important as the benefit of the prolonged life span of PLHIV offered by ART drugs is translated to an increased risk of hypertension due to aging.

Declarations

Ethics approval and consent to participate

The project was approved by the National Health Research Ethics Committee (NHREC), Nigeria with the ethical approval number of NHREC/01/01/2007-18/01/2022. We obtained written informed consent from all patients who participated in the study.

Consent for publication

Not applicable.

Author contributions

Oluseye Ayodele Ajayi: Conceptualization; Data curation; Formal analysis; Methodology; Project administration; Writing – original draft.

Deborah Babatunde: Formal analysis; Writing – original draft.

Oluwaseun Kikelomo Ajayi: Data curation; Methodology; Writing – original draft.

Temitope Olumuyiwa Ojo: Methodology; Writing – original draft; Writing – review & editing.

Prosper Okonkwo: Conceptualization; Writing – original draft; Writing – review & editing.

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Competing interests
The authors declare that there is no conflict of interest.

Availability of data and materials
The survey data is available upon reasonable request to the corresponding author

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References

1. FMOH Nigeria. National guideline for HIV and AIDs treatment and care 2016. https://www.who.int/hiv/pub/guidelines/nigeria_art.pdf (accessed January 2023).
2. aidsmap. HIV and AIDs: Sharing knowledge, changing lives. https://www.aidsmap.com/about-hiv/life-expectancy-people-living-hiv. (2021, accessed January 2023).
3. Autenrieth CS, Beck EJ, Stelzle D, et al. Global and regional trends of people living with HIV aged 50 and over: estimates and projections for 2000-2020. *PLoS One* 2018; 13(11): e0207005.
4. Ekrikpo UE, Akpan EE, Ekott JU, et al. Prevalence and correlates of traditional risk factors for cardiovascular disease in a Nigerian ART-naive HIV population: a cross-sectional study. *BMJ Open* 2018; 8: e019664.
5. So-Armah K, Benjamin LA, Bloomfield GS, et al. HIV and cardiovascular disease. *Lancet HIV* 2020; 7(4): e279–e293.
6. Xu Y, Chen X and Wang K. Global prevalence of hypertension among people living with HIV: a systematic review and meta-analysis. *J Am Soc Hypertens* 2017; 11(8): 530–540.
7. Ogunmola OJ, Oladosu OY and Olamoyegun AM. Association of hypertension and obesity with HIV and antiretroviral therapy in a rural tertiary health center in Nigeria: a cross-sectional cohort study. *Vasc Health Risk Manag* 2014; 10: 129–137.
8. Isa SE, Kang'ombe AR, Simji GS, et al. Hypertension in treated and untreated patients with HIV?: a study from 2011 to 2013 at the Jos University Teaching Hospital, Nigeria. *Trans R Soc Trop Med Hyg* 2017; 111(4): 172–177.
9. Marin S, Quiñones C, Codina-Jiménez C, et al. The management of polypharmacy in people living with HIV. *AIDS Rev* 2023; 25(1): 27–40.
10. Gausi B, Berkowitz N, Jacob N, et al. Treatment outcomes among adults with HIV/non-communicable disease multimorbidity attending integrated care clubs in Cape Town, South Africa. *AIDS Res Ther* 2021; 18: 72.
11. Resolve to Save Live. Integrating hypertension treatment with HIV care in Uganda. https://resolvetosavelives.org/cardiovascular-health/success/hiv-htn-uganda (2019, accessed 23 June 2023).
12. Isaac Derick K and Khan Z. Prevalence, awareness, treatment, control of hypertension, and availability of hypertension services for patients living with human immunodeficiency virus (HIV) in Sub-Saharan Africa (SSA): a systematic review and meta-analysis. *Cureus* 2023; 15(4): e37422.
13. NCD Risk Factors Collaborators. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. *Lancet* 2021; 398: 957–980.
14. Manavalan P, Madut DB, Hertz JT, et al. Hypertension burden and challenges across the hypertension treatment cascade among adults enrolled in HIV care in northern Tanzania. *J Clin Hypertens (Greenwich)* 2020; 22: 1518–1522.
15. Hoffman RM, Chibwana F, Kahn D, et al. High rates of uncontrolled blood pressure in Malawian adults living with HIV and hypertension. *Glob Heart* 2021; 16: 81.
16. Kwarisiima D, Balzer L, Heller D, et al. Population-based assessment of hypertension epidemiology and risk factors among HIV-positive and general populations in rural Uganda. *PLoS One* 2016; 11: e0156309.
17. Melaku T, Chelkeba L and Mekonnen Z. Clinical care & blood pressure control among hypertensive people living with human immune deficiency virus: prospective cohort study. *Ann Med Surg* 2020; 54: 114–124.
18. Jackson IL, Lawrence SM, Igwe CN, et al. Prevalence and control of hypertension among

people living with HIV receiving care at a Nigerian hospital. *Pan Afr Med J* 2022; 41: 153.

19. Nascimento Costa A, Val F, Elias Macedo Á, et al. Increased prevalence of hypertension among people living with HIV: where to begin? *J Brazilian Soc Tropical Med* 2020; 53: e20190564.
20. Oyo State Demographics, https://citypopulation.de/en/nigeria/admin/NGA031__oyo/ (2022, accessed 18 June 2023).
21. FMOH. National Summary Sheet. Nigeria HIV/AIDs indicator and impact survey, https://www.naiis.ng/resource/factsheet/NAIIS%20National%20Summary%20Sheet.pdf. (2018, accessed 18 June 2023).
22. Ajayi IO, Sowemo IO, Akpa OM, et al. Prevalence of hypertension and associated factors among residents of Ibadan-North Local Government Area of Nigeria. *Nig J Cardiol* 2016; 13: 67–75.
23. Shittu RO, Odeigah LO, Fakorede KO, et al. Prevalence and correlates of hypertension-outcome of a free medical screening in Oke-Ogun area of Oyo state, Nigeria, West Africa. *J Am Soc Hypertens* 2018; 12(4): 268–274.
24. Plateau State Demographics, https://citypopulation.de/en/nigeria/admin/NGA032__plateau/ (2022, accessed 18 June 2023).
25. Daboer JC, Ismaila EL, Ibrahim ZS, et al. Prevalence of noncommunicable disease risk factors among market traders in Jos North Local Government Area, Plateau State Nigeria. *Niger J Clin Pract* 2021; 24(4): 476–482.
26. Selowo TT. Prevalence of hypertension and assessment of its risk factors among traders in Rukuba-Road Satellite Market in Jos, North Central Nigeria. *Nigeria J Med* 2021; 30(6): 2021.
27. Ilesanmi OS and Akpa OM. Prevalence and risk factors of hypertension in HIV-positive adults on antiretroviral therapy in Ondo State, Nigeria. *HIV AIDS Rev* 2020; 19: 199–205.
28. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008; 61(4): 344–349.
29. Badru O, Oduola T, Abdulrazaq A, et al. Prevalence and predictive factors of hypertension among people living with HIV in Kebbi State, Nigeria: a Cross-sectional Study. *J Association Nurses AIDS Care* 2022; 33(1): e6–e14.
30. Odubela O, Odunukwe N, Peer N, et al. Prevalence of hypertension among antiretroviral therapy naïve patients in Lagos, Nigeria. *Clin Hypertens* 2023; 29: 29.
31. Muddu M, Tusubira AK, Sharma SK, et al. Integrated hypertension and HIV care cascades in an HIV treatment program in Eastern Uganda: a Retrospective Cohort Study. *J Acquir Immune Defic Syndr* 2019; 81(5): 552–561.
32. Jackson IL, Igwe CN and Eshiet UI. Pharmacological management of HIV infection and hypertension and its impact on disease control in hypertensive people living with HIV. *Int J Pharm Sci Rev Res* 2022; 77(2): 133–138.
33. Husain MJ, Datta BK, Kostova D, et al. Access to cardiovascular disease and hypertension medicines in developing countries: an analysis of essential medicine lists, price, availability, and affordability. *J Am Heart Assoc*. 2020; 9(9): e015302. doi: 10.1161/JAHA.119.015302
34. Dangiwa DA, Hayab EM, Ogundeko TO, et al. Affordability of anti-hypertensive and anti-hypertensive co-morbid with diabetes in Jos and environs, Central Nigeria. *GSC Biol Pharm Sci* 2022; 21(02): 105–111.
35. Fiseha T, Belete AG, Dereje H, et al. Hypertension in HIV-infected patients receiving antiretroviral therapy in Northeast Ethiopia. *Int J Hypertens* 2019; 2019: 7.
36. Khawcharoenporn T and Tanslaruk V. Does polypharmacy affect treatment outcomes of people living with HIV starting antiretroviral therapy? *Int J STD AIDS* 2020; 31(12): 1195–1201.
37. Rethy LB, Feinstein MJ, Achenbach CJ, et al. Antihypertensive class and cardiovascular outcomes in patients with HIV and hypertension. *Hypertension* 2021; 77: 2023–2033.
38. European AIDS Clinical Society Guidelines English Version 12.0. October 2023. English. https://www.eacsociety.org/media/guidelines-12.0.pdf. (accessed 18 June 2023).
39. Fischetti B, Sorbera M, Michael R, et al. Evaluation of rates of virologic suppression in HIV-positive patients with varying numbers of comorbidities. *Am J Health-Syst Pharm* 2002; 79(2): 72–77.