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Prevalence and risk factors of hypertension among HIV patients: A retrospective cross sectional study of a Nigerian tertiary hospital

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Abstract

Background: Recent studies have linked HIV and antiretrovirals with cardiovascular conditions including hypertension (HTN). HIV/HTN comorbidity may not only worsen prognosis of the diseases but may pose the challenge of non-adherence due to increased pill burden and side effects.

Objectives: This study seeks to determine the prevalence and risk factors of hypertension among HIV patients.

Methods: The study was a retrospective cross-sectional research among 254 people living with HIV (PLWH) on antiretroviral therapy (ART) at the Federal Medical Centre (FMC), Makurdi, Benue State, Nigeria, who were seen by a physician between January and August 2022. A validated data collection sheet containing all required variables was used.

Results: The prevalence of hypertension among the population of study was 15.4%. The final regression model showed that occupational status, educational level, and difference in CD4 count were not significant predictors. Increasing age (OR = 1.066; CI = 1.013 – 1.121; P = 0.014) and body mass index (BMI: OR = 1.274; CI = 1.149 – 1.413; P = 0.000) were seen to be associated with increased odds of developing hypertension.

Conclusion: The prevalence of hypertension in this study population was high. Traditional risk variables (advanced aged and increased BMI) were independently, significantly associated with hypertension but neither CD4 count, viral load nor ART use were significantly associated with it. The findings support the development of guidelines for routine blood pressure monitoring for PLWH receiving ART.

Keywords: Prevalence; Hypertension; HIV; ART (Antiretroviral therapy); PLWH (People living with HIV)

1. Introduction

Human immunodeficiency virus (HIV) infection is a chronic viral infection that requires life-long treatment. In the same vein, hypertension (HTN) is a chronic cardiovascular condition requiring life-long management. HIV infection and HTN comorbidity may pose a serious challenge to treatment adherence and cause several other complexities including cardiovascular events.

The estimated global prevalence of HIV among persons aged 15 -49 is 0.7% (0.6-0.9), although the epidemic's toll constantly fluctuates greatly between nations and areas. The African region is the most severely impacted, with

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approximately 1 in every 25 adults (3.6%) living with HIV, making up more than two-third of all HIV-positive people worldwide [1].

HIV infection is a major public health challenge and Sub-Saharan Africa is severely affected by this epidermic. In Nigeria, women were the foremost affected group, counting 960,000 individuals. Children up to 14 years who were HIV positive equaled to 130, 000 [2]. Adult prevalence of HIV infection among persons aged 15 -49 years in Nigeria is 1.4% [3].

Antiretroviral drugs have turned the infection from almost always fatal to a manageable chronic condition. However, there is a growing concern that the metabolic complications associated with HIV and ART may increase cardiovascular risk and lead to cardiovascular disease [4]. A review by Alinda Vos et al. provided updates on cardiovascular toxicity of contemporary ART. According to their review, cardiovascular risks, including heart failure were still increased in people living with HIV (PLWH). Weight gain on newer antiretrovirals including integrase inhibitors was considered a concern [5] as it is considered a risk factor for hypertension. Similarly, Sanusi et al showed that exposure to highly active antiretroviral therapy (HAART) whilst improving the immune status of the patients predisposes them to development of hypertension, dyslipidemia and metabolic syndrome [4]. According to Masenga at al., Antiretroviral Therapy (ART) was developed to improve the survival of HIV-positive persons, but this achievement was accompanied by a high prevalence of cardiovascular illnesses [6].

Aside antiretrovirals being linked to cardiovascular conditions, certain studies have proposed that HIV infection was a risk factor for hypertension. The mechanisms for HTN in HIV infection and ART have been proposed by several authors. HIV was reported to cause HIV-induced inflammation, hypercoagulability and platelet activation which contributed to endothelial dysfunction and subsequent increased cardiovascular risks [7, 8, 9]. Peck et al opined that the high prevalence of hypertension among HIV-infected adults on ART could be related to dysregulated inflammation due to immune reconstitution [10]. According to Fahme et al, the novel pathophysiologic mechanisms for hypertension in HIV-infected adults may include microbial translocation, chronic inflammation, immune suppression and reconstitution, viral tropism, lipodystrophy, adipokines and HIV-related renal disease [11]. In the same vein, data from Manner et al suggested that microbial translocation and immune activation might be linked to the development of hypertension in HIV infection [12]. There is, therefore, need for continuous monitoring of patients not only for effective delivery of ART in other to evaluate therapeutic response and identify side effects but for cardiovascular problems such as hypertension.

Hypertension is one of the major causes of death worldwide and is viewed as a developing issue in HIV-positive individuals [10, 13]. Adults with HIV who are on ART have a higher prevalence of hypertension than those without the virus [14]. A meta-analysis of data around the globe showed that 35% of all HIV-infected adults on ART had hypertension compared to an estimated 30% of HIV-uninfected adults. The result of the meta-analysis observed that more than 50% of ART-experienced individuals greater than 50years had hypertension [15]. Bloomfield et al. reviewed the danger of hypertension in HIV infection. According to them, HIV-uninfected adults with hypertension or HIV-infected adults without hypertension have a lower risk of cardiovascular events and an all-cause mortality than HIV-infected adults with hypertension [16]. This makes the determination of hypertension prevalence in HIV-infected persons very paramount.

It has been suggested that nations with a high HIV prevalence, such as Nigeria, may also have a high prevalence of non-communicable illnesses (NCDs), such as hypertension [17]. Paula et al. in their study showed that CVD death is four times higher in PLHIV than in HIV-negative people [18]. Despite this high prevalence, data suggests that hypertensive PLHIV receive sub-optimal hypertension treatment [14]. Furthermore, despite the fact that PLHIV have regular and routine access to health care, multiple studies have found that rates of blood pressure control are poor in those with concomitant hypertension [17, 19], implying that HIV clinics may have a one-dimensional emphasis of care [14].

The objectives of this study was to determine the prevalence and risk factors of hypertension among HIV patients in Federal Medical Center Makurdi, Benue State, Nigeria. The study also determined the relationship between hypertension and immunologic (CD4 count) and virologic (Viral Load) outcomes of HIV treatment.

The findings of this study will make available data that will serve as a guide towards developing a more comprehensive approach for HIV patient care.

2. Material and methods

2.1. Study Setting

The study was carried out at the Federal Medical Centre (FMC), Makurdi. FMC Makurdi is a more than 400 bedded tertiary care hospital located in Makurdi, Benue state, North-central region of Nigeria. While the hospital serves as a referral center for tertiary care, it also renders both primary and secondary care. The hospital has antiretroviral treatment center supported by AIDS Prevention Initiative, Nigeria (APIN). The center provides HIV Voluntary Counseling and Testing (VCT), treatment and care for HIV/AIDS patients as well as Prevention of Mother-to-Child Transmission (PMTCT).

2.2. Study Design

The study was a retrospective cross-sectional research that extracted data from case files of patients who accessed care from January to August 2022.

2.3. Study Population

The study population included adults aged 18 years and older as at the time of this study, who had been diagnosed of HIV, and were currently receiving ART in the facility. Patients who had been on ART for a minimum of two years and who had been seen by the physician within the study period of January, 2022 to August, 2022. Pregnant women and breast-feeding mothers, children below 18 years of age and participants with up to three missing data were exempted from the study.

2.4. Sampling Method and Sample Size

Sample size for the study was calculated using Taro Yamane's formula as shown by Rafael, 2014 [20]. With an estimated population of 698, a sample size of 254 was arrived at. Simple random sampling technique was used to select participants. Participants (case files) were assigned codes which were put together to form a pool. 254 participants were then drawn from the pool.

Note: N = total number of patients that had seen a physician and met all the inclusion criteria within the study period as obtained from the ICT unit of the facility. It is worthy to note also that patients who are stable on their medications do not always see the Physician but the Pharmacist for refill and counselling.

2.5. Method of Data Collection

Based on the specified variables; a checklist was created. Variables obtained from PLWH records included hypertension status, sex, age, height, weight, marital status, occupational status, educational level, CD4 count (before ART initiation and at present), current blood pressure measurement, time since ART initiation, viral load (at the start of ART and at present), specific ART being used.

2.6. Data Analysis

Data were analyzed using IBM SPSS version 22. The classical Quetelet index was used to compute body mass index (BMI): weight divided by height squared (kg/m^2) [21]. Underweight ($>18.5 \ kg/m^2$), normal weight ($18.5–24.9 \ kg/m^2$), overweight ($25–29.9 \ kg/m^2$), and obese ($30 \ kg/m^2$) were the four BMI categories. Hypertension diagnosis was defined when the two readings obtained were equal to or above 140 or 90 mmHg, or current use of antihypertensive therapy. Frequencies and percentages were used to summarize categorical data. Median (interquartile range, IQR) were used to summarize continuous data. Binary logistic regression analyses were carried out to examine associations between each patient variable and hypertension status. Finally, the significant variables were included in a multivariate logistic regression model to determine the true predictors of hypertension. All analyses were considered significant at $p < 0.05$. Tables were used to present all findings.

2.7. Ethical Issues

The ethical clearance addressed concerns about patient confidentiality, justice, rights, and respect for the patients and their records. The study was approved by the Federal Medical Center Makurdi Research Ethics Committee. The patient data in databases was de-linked using patient codes to avoid bias and ensure confidentiality.

3. Results

Out of the 698 prospective participants, 254 participants were randomly sampled, out of whom 165 (65%) were females. The median (IQR) age was 46 (14). Most of the participants were married (59.4%). Farmers represented (31.5%) and skilled workers (28.7%) of the study participants. Secondary (37.5%) and tertiary (24.4%) educational levels were more common. Majority of the participants were on Tenofovir disoproxil fumarate (TDF) based combination (221 (87%). BMI of 18.5 -24.9kg/m2 had the highest occurrence (145) representing 57.1%. The prevalence of hypertension among the population of study was 15.4%. See table 1 below. The mean change in CD4 count (cells/m^3) was 108.5 with IQR of 305 while that of change VL (copies/ml) was -37 with IQR of 191.8. From the binary logistic regression analysis, it was observed that age, occupational status, educational level, difference in CD4 count and body mass index were independent predictors of hypertension in the population being studied. However, in the final regression model, occupational status, educational level, and difference in CD4 count were not significant predictors. Increasing age (OR = 1.066; CI = 1.013 – 1.121; P = 0.014) and body mass index (OR = 1.274; CI = 1.149 – 1.413; P = 0.000) in the study population were significantly associated with increased odds of developing hypertension. See table 2.

Table 1 Socio-demographic Characteristics of Study Population

Socio-demographic Characteristics	Frequency (n)	Percentage (%)
Hypertension Status		
Normotensive	215	84.6
Hypertensive	39	15.4
Gender		
Male	89	35.0
Female	165	65.0
Marital Status		
Single	39	15.4
Widowed	47	18.5
Married	151	59.4
Separated	17	6.7
Occupational Status		
Student/Applicant	44	17.3
Civil Servant	56	22.0
Trader/Skilled Laborer/Self-employed	73	28.7
Retired	-	-
Farmer	80	31.5
Missing	1	0.4
Educational Level		
None	48	18.9
Primary	49	19.3
Secondary	95	37.5
Tertiary	62	24.4
Therapy Type		
ABC based	1	0.4

TDF based	221	87.0
AZT based	32	12.6
BMI (Kg/m²)		
<18.5	21	8.3
18.5 – 24.9	145	57.1
25.0 – 29.9	62	24.4
≥ 30.0	26	10.2
	Median	IQR
SBP (mmHg)	110.0	20.0
DBP (mmHg)	70.0	15.0
Age (years)	46.0	14.0
Initial CD4 Count (cells/mm³)	419.0	245.0
Current CD4 Count (cells/mm³)	540.5	334.0
Initial Viral Load (copies/mL)	48.5	180.0
Current Viral Load (copies/mL)	19.0	20.0
Change in CD4 count (cells/mm³)	108.5	305.0
Change in Viral Load (copies/mL)	-37.0	191.5
Duration on ART (year)	11.0	5.0

IQR – interquartile range; BMI – body mass index; SBP – systolic blood pressure; DBP – diastolic blood pressure; TDF – tenofovir; AZT – zidovudine; ABC – abacavir; ART – antiretroviral therapy

Table 2 Result of binary logistic regression to determine predictors of hypertension

Variable	Unadjusted OR (CI)	P	Adjusted OR (CI)	P
Age	1.078 (1.043 – 1.114)	0.000	1.066 (1.013 – 1.121)	0.014
Gender				
Male	1.094 (0.531 - 2.251)	0.808		
Marital Status				
Single		0.67		
Widowed	1.829 (0.189 – 17.695)	0.602		
Married	6.118 (0.735 – 50.914)	0.94		
Separated	2.585 (0.325 – 20.528)	0.369		
Occupational Status**				
Student/Applicant		1.0		1.000
Civil Servant	1.043 (0.288 – 3.779)	0.949	3.271 (0.646 – 16.558)	0.152
Trader/Skilled Laborer/Self-employed	3.815 (1.439 – 10.118)	0.007	3.956 (0.573 – 27.321)	0.163
Farmer	2.260 (0.848 – 6.022)	0.103	4.432 (1.144 – 17.166)	0.310
Educational Level				

None		0.024		0.098
Primary	4.326 (1.562 – 11.983)	0.05	2.655 (0.581 – 12.132)	0.208
Secondary	2.894 (0.943 – 8.882)	0.063	3.907 (0.933 – 16.368)	0.062
Tertiary	4.410 (1.519 – 12.806)	0.06	5.927 (1.213 – 28.949)	0.028
Therapy Type**				
TDF based	0.150 (0.020 – 1.135)	0.66		
AZT based	6.402 (0.848 – 48.345)	0.72		
Current CD4 Count	1.0 (0.999 – 1.002)	0.647		
Current Viral Load	1.0 (1.0 – 1.0)	0.196		
Change in CD4 count	0.999 (0.997 – 1.000)	0.046	0.999 (0.997 – 1.000)	0.108
Change in Viral Load	1.0 (1.0 – 1.0)	0.352		
BMI	1.277 (1.172 – 1.392)	0.000	1.274 (1.149 – 1.413)	0.000
Duration on ART	1.132 (0.975 – 1.315)	0.103		

**N = 253; N = 254; BMI – body mass index; ART – antiretroviral therapy; TDF – tenofovir; AZT – zidovudine; CI – confidence interval; OR – odds ratio; $p < 0.05$

4. Discussion

The purpose of the current study was to determine the prevalence and risk factors of hypertension among PLWH seeking medical care at FMC, Makurdi, Benue State, Nigeria. Using the JNC 7 criteria for the classification of hypertension, the prevalence of hypertension in the study population was 15.4%. The prevalence is similar to those reported by Deo Harimenshi et al. in Burundi (17.5%) [7] and by Okpa et al. in South-South region of Nigeria (13.3%) [22]. However, Oluwakemi et al., Ilesanmi and Akpa both from South Western Nigeria and Jackson et al. from South-South Nigeria, in their investigations, reported prevalence figures of 26.7%, 24.9% and 20.3% respectively which were higher compared to the current study [23, 24, 25].

In general, variations in prevalence and incidence of hypertension are brought on by the differences in the characteristics of the study population, the design of the study and methodology, cut-off points, and references for definition of hypertension [26]. A high prevalence as obtained above could likely be associated with the continuous immune activation and inflammatory processes which are common phenomena in HIV-infected persons, overweight and older age. Other factors which were not tested but are thought to have been associated with high prevalence of hypertension include: poor cardiovascular education, sedentary life style, smoking, alcohol consumption, poor diet e.t.c. To lower the risks of cardiovascular diseases, which are increasingly linked to mortality in this patient population, efforts to appropriately manage hypertension in HIV-positive individuals should be increased [27]. Also, the institution of routing checks for hypertension among HIV patients should be given paramount consideration.

The multivariate logistic regression model revealed that the patients; age and BMI were important predictors of hypertension in these patients. Patient age strongly predicting hypertension in this study is consistent with the findings of other researches [24, 28, 29]. Aging related vascular changes that predispose one to hypertension include the advanced decline in visco-elastic properties of vessels, the progression of atherosclerotic arterial disease, and the hypertrophy/sclerosis of muscular arteries and arterioles, which cause the vessels' walls to constrict and increase resistance to pressure and flow [26]. These could be related to high blood pressure either directly or indirectly. It is, therefore, important that as HIV-positive patients age, there should be routine screening, proper management and adequate counseling on cardiovascular health.

The current study's findings supported earlier research findings that BMI is predictor of hypertension in PLWH [22, 24, 30, 31, 32]. The result of this research reinforce the notion that BMI is a recognized risk factor for developing hypertension in both the general population and HIV-infected people as stated by Okpa et al. [22]. The implication is that increasing BMI increases the chances of developing hypertension. Although improving a healthy lifestyle to lower BMI has not received top priority in lowering hypertension in many underdeveloped and developing countries, BMI is an important modifiable risk factor [33]. To minimize overweight and obesity among PLWH, weight loss, exercise and healthy nutrition are necessary [34].

The duration on ART was not a significant predictor of hypertension in this research. This was in line with a previous study that found no association between hypertension and ART duration in HIV-positive individuals who had been on treatment for more than 2 years [10]. In another investigation also, Rodriguez-Arboli et al. discovered that among HIV-positive people, the duration of ART exposure was not a significant predictor of new-onset hypertension [35]. The duration of ART, nevertheless, was a highly independent predictor of hypertension in some other study [36]. Jackson et al. also, in their final logistic model noted that among HIV patients, the duration of ART was a highly significant predictor of hypertension [24]. The variation in the outcome of these investigations might be a subject for further research.

In our study, the common drug combination being used was Tenofovir-based (87%). Some other patients were on Zidovudine-based combination (12.6%). These drugs were not found to be significant predictors of hypertension in both models. Similar results were observed in a prior study [26, 30].

It has been observed recently that some antiretroviral drug combinations used to treat HIV infection can increase the risks for co-morbidities like hypertension, hyperlipidemia and insulin resistance, which are known to increase vascular atherosclerosis and overall CVD risk [27]. These are some known side effects. Nevertheless, according to Palellar and Phair, the overall effect of ARV use on CVD risks like hypertension is beneficial, largely (but not necessarily completely) mitigating the negative effect of HIV on vascular health and CVD risk by enabling profound and durable suppression of HIV replicability. Palellar and Phair opined that with today's modern ARV medications, which are stronger, less toxic, and seem to have less of an unfavourable effect on classic CVD risks, this is probably even more the case [27]. Deducing from this, the newer ARTs being prescribed may not be a significant predictor of hypertension in HIV-positive individuals but their effects over time especially as the patients age and present with other conditions needs to be further studied.

The current study showed no association between hypertension and immunologic and virologic outcomes of HIV treatment (CD4 count and viral load). This is in line with a study by Rodriguez-Arboli et al. who reported that, baseline CD4 count was not an independent predictor of new-onset hypertension among HIV-infected adults [35]. On the other hand, a study found an interaction between the effect of detectable plasma viral load (pVL) on hypertension on both multiplicative and additive scales. According to this, PLWH with detectable pVL should receive comprehensive management and monitoring for the purpose of preventing and treating hypertension [37]. Another study observed an inverse correlation between the risk for hypertension and the presence of severe HIV disease (indicated by a low CD4+ T-cell count and an advanced WHO clinical disease stage) [38]. Advanced and severe CD4 levels were, in different studies, observed to be independently associated with hypertension [12, 39]. The hypothesized mechanism for the correlation between low immunity and CVD risk is that chronic inflammation that comes along with uncontrolled or more advanced HIV disease is linked to elevated levels of serum makers of inflammation, elevated levels of activated CD4+ T-cells, and elevated levels of proinflammatory cytokines that destabilize atherosclerotic plaques and result in CVD events [40].

It is very glaring that there are variations in the outcomes of the various studies. A possible cause for these variations could be the different cut-off points used. A standardized, multi-centered study using same cut-off points would give a better picture of the relationship between these variables.

5. Conclusion

The prevalence of hypertension in this study population was high. Known risk variables significantly associated with hypertension in PLWH were age and BMI, but neither CD4 count, viral load nor ART regime as well as duration of treatment were significantly associated with hypertension in HIV. This high prevalence is of clinical significance. HIV/HTN comorbidity may result to increased drug therapy problems, increased pill burden, reduced adherence, increased morbidity and mortality. These underscore the need for evidence-based non-communicable disease management techniques to be incorporated into integrated HIV programs in Benue State, Nigeria and to support the establishment of universal routine hypertension screening for HIV patients.

Limitations

Because the data collected was retrospective, we had no control over its quality and could not account for missing data and, in some cases, outright loss of important information. Also, we could not forecast the onset of hypertension in the future because there is no follow-up regarding changes in the status of hypertension among the group under study. Despite these drawbacks, the study contributes important information about the significance of hypertension and causal risk among high-risk HIV people taking ART in Benue State.

Recommendation

- It is essential to develop guidelines for routine blood pressure monitoring for PLWH receiving ART.
- The predictors of hypertension in HIV-positive patients should be taken into account by Clinicians in setting priorities and in regular clinical practice for PLWH. This is because early detection can reduce morbidity associated with the condition.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

Authors declared no conflict of interest

Statement of ethical approval

Ethical approval was obtained from the hospitals ethical research committee (HERC) before the conduct of this study. Confidentiality of participants' information was ensured.

Statement of informed consent

Informed consent was obtained from all individual patients whose data were used for the study.

Author's Contribution

All authors contributed substantially to the conduct of the study and have approved the version to be published while agreeing to take responsibility for all aspects of the work.

References

[1]   World Health Organisation (2022, June 14). Hypertension: overview, symptoms and treatment. Retrieved from https://www.who.int/health-topics/hypertension. Accessed on 10th September, 2022.

[2]   Statistica Research Department (2020). Prevalence of HIV in Nigeria. Retrieved from https://www.statistica.com/statistics/1262126/prevalence-of-hiv-in-nigeria.

[3]   United Nations, General Assembly. Global Report (2019, December 04). UNAIDS Report on the Global AIDS Epidermic. Retrieved from https://www.unaids.org/en.

[4]   Sanusi Mohammed, Mahmoud Umar Sani and Basi N Okeahialam (2013). Cardiovascular disease risk factors among HIV-infected Nigerians receiving highly active antiretroviral therapy. Niger Med J, 2013 may-Jun; 54(3): 185-190.doi: 10.4103/03001652.114591.PMCID: PMC 371945/PMID: 23901181.

[5]   Vos Alinda and Venter WDF (2021). Cardiovascular toxicity of contemporary antiretroviral therapy. Curr Opin in HIV and AIDS. November 2021, volume 16, issue 6, page 286-291.doi:10.1097/COH.0000000000000702.

[6]   Masenga, SK, Hamooya, BM, Nzala, S et al (2019). Patho-immune Mechanisms of Hypertension in HIV: a Systematic and Thematic Review. Curr Hypertens Rep 21, 56 (2019). https://doi.org/10.1007/s11906-019-0956-5.

[7]   Deo Harimenshi, Theordore Niyongabo, Pierre-Marie Preux, Victor Aboyans and Ileana Desormais (2022). Hypertension and associated factors in HIV-infected patients receiving antiretroviral treatment in Burundi: a cross sectional study. Sci Rep. 2022;12:20509.doi: 101038/s41598-022-2499-7. PMCID: PMC9705296/PMID: 36443478.

[8]   Nemeth CL, Bekhbat M, Neigh GN (2015). Neural effects of inflammation, cardiovascular disease, and HIV: parallel, perpendicular, or progressive? Neuroscience. 2015;302:165-73.doi: 10.1016/j.neuroscience.2014.09.016. Epub 2014 Sep 17. PMID: 25239371; PMCID: PMC6492036.

[9]   Fourie C, Van Rooyen J, Pieters M, Conradie K, Hoekstra T and Schutte A (2011). Is HIV-1 infection associated with endothelial dysfunction in a population of African ancestry in South Africa?: cardiovascular topics. Cardiovascular Journal of Africa, 22(3): 134-140.doi:10.5830/cvja-2010-056. PMID: 21713302; PMCID: PMC3721955.

[10]   Peck RN, Shedafa R, Kalluvya S, Downs JA, Todd J, Suthanthiran M,… and Kataraihya JB (2014). Hypertension, kidney disease, HIV and antiretroviral therapy among Tanzanian adults: a cross sectional study. BMC Medicine, 12, 125 (2014).https://doi.org/10.1186/s12916-014-0125-2.

[11]   Fahme SA, Bloomfield GS and Peck R (2018). Hypertension in HIV-infected adults: novel pathophysiologic mechanisms. Hypertension. 2018; 72(1):44-55.https://doi.org/10.1161/HYPERTENSIONAHA.118.10893/

[12]   Manner, I. W., Baekken, M., Kvale, D., Oektedalen, O., Pedersen, M., Nielsen, S. D., Nowak, P., Os, I., & Trøseid, M. (2013). Markers of microbial translocation predict hypertension in HIV-infected individuals. HIV medicine, 14(6), 354–361. https://doi.org/10.1111/hiv.12015

[13]   Ryacavage P, Still W, Nyemba V and Stafford K (2017). Prevalence of Systemic Hypertension Among HIV-Infected and HIV-Uninfected Young Adults.Open Forum Infectious Disease, 4(Suppl 1), S59.https://doi.org/10.1093/ofid/ofx162.138.

[14]   Nguyen KA, Peer N, Mills EJ and Kengne AP (2015). Burden, determinants and pharmacological management of hypertension in HIV-positive patients and populations: a systematic narrative review. AIDS Rev, 17(2): 83-95. PMID: 26035166.

[15]   Xu y, Chen X and Wang K (2017). Global prevalence of hypertension among People living with HIV: a systematic review and meta-analysis. Journal of the American Society of Hypertension. 2017; 11(8):530-540.

[16]   Bloomfield GS, Khazainie P, Morris A, Rabadan-Diehl C, Benjamin LA, Murdoch D…..and Hicks C (2014). HIV and non-communicable cardiovascular and pulmonary diseases in low- and middle-income countries in the ART era: what we know and the best direction for future research. Journal of acquired immune deficiency syndromes (1999), 67(01), S40.

[17]   Jackson IL and Ukwe CV (2021). Clinical outcomes of pharmaceutical care interventions in HIV positive patients with hypertension: a randomized controlled study. Journal of Clinical Pharmacy and Therapeutics, 46(4): 1083-1094.

[18]   Paula AA, Schechter M, Tuboi SH, Faulhaber JC, Luz PM, Veloso VG….. and Pacheco AG (2014). Continuous increase of cardiovascular diseases, diabetes and non-HIV related cancers as causes of death in HIv-infected individuals in Brazil: an analysis of nationwide data. ploS one, 9(4): e94636.

[19]   Hing M, Hoffman RM, Seleman J, Chibwana F, Kahn D and Moucheraud C (2019). 'Blood pressure can kill you tomorrow, but HIV gives you time': Illness perception and treatment experiences among Malawian individuals living with HIV and hypertension. Health policy and planning, 34&Supplement_2): ii36-ii44.

[20]   Rafael C (2014). How to calculate sample size using Taro Yamane's formula. Retrieved from https://www.nairaproject.com/blog/its-taro-yamane-not-yaro.html.

[21]   Zierle-Ghosh A and Jan A (2022). Body mass index. Updated 2022 Sep 11. In. StatPearls [internet].Treasure Island (FL): StatPearls Publishing; 023 Jan. www.ncbi.nlm.nih.gov. Accessed on 12th May, 2023

[22]   Okpa HO, Bisong EM, Enang OE, Monjok E and Essien EJ (2017). Predictors of hypertension in an urban HIV-infected population at the University of Calabar Teaching Hospital, Calabar, Nigeria. HIV/AIDS (Auckland, N.Z.), 9:19-24.https:/ doi.org/ 10.2147 /HIV.S126374.

[23]   Oluwakemi O, Oluwabusayo B, Kolawole S and Tope O (2020). Behavioural risk factors for hypertension among adults living with HI accessing care in a secondary health facility in Lagos State, Nigeria. J Family Med Prim Care. 2020 Jul; 9(7): 3450-3457.doi: 10.4103/jfmpc.jfmpc_544_20. PMCID: PMC7567202/PMID: 33102312.

[24]   Jackson IL, Lawrence SM, Igwe CN, Ukwe CV and Okonta JM (2022). Prevalence and control of hypertension among people living with HIV receiving care at a Nigerian hospital. The Pan African Medical Journal, 41, 153.https://doi.org/10.11604/pamj.20 22.41.153.21809.

[25]   Ilesanmi OS amd Akpa OM (2020). Prevalence and risk factors of hypertension in HIV_positive adults on antiretroviral therapy in Ondo State, Nigeria. HIV and AIDS Review. International journal of HIV-Related Problems, 19(3):199-205.

[26] Hejazi, N., Huang, M. S., Lin, K. G., & Choong, L. C. (2013). Hypertension among HIV-infected adults receiving highly active antiretroviral therapy (HAART) in Malaysia. Global journal of health science, 6(2), 58–71. https://doi.org/10.5539/gjhs.v6n2p58

[27] Palella, F. J., Jr, & Phair, J. P. (2011). Cardiovascular disease in HIV infection. Current opinion in HIV and AIDS, 6(4), 266–271. https://doi.org/10.1097/COH.0b013e328347876c.

[28] Isa, S. E., Kang'ombe, A. R., Simji, G. S., Shehu, N. Y., Oche, A. O., Idoko, J. A., Cuevas, L. E., & Gill, G. V. (2017). Hypertension in treated and untreated patients with HIV: a study from 2011 to 2013 at the Jos University Teaching Hospital, Nigeria. Transactions of the Royal Society of Tropical Medicine and Hygiene, 111(4), 172–177. https://doi.org/10.1093/trstmh/trx030

[29] de Arruda Junior, E. R., Lacerda, H. R., Moura, L. C. R. V., de Barros Miranda Filho, D., Diniz, G. T. N., de Albuquerque, V. M. G., ... & Monteiro, V. S. (2010). Risk factors related to hypertension among patients in a cohort living with HIV/AIDS. The Brazilian Journal of Infectious Diseases, 14(3), 281-287.

[30] Medina-Torne, S., Ganesan, A., Barahona, I., & Crum-Cianflone, N. F. (2012). Hypertension is common among HIV-infected persons, but not associated with HAART. Journal of the International Association of Physicians in AIDS Care, 11(1), 20-25.

[31] Kwarisiima, D., Balzer, L., Heller, D., Kotwani, P., Chamie, G., Clark, T., Ayieko, J., Mwangwa, F., Jain, V., Byonanebye, D., Petersen, M., Havlir, D., & Kamya, M. R. (2016). Population-Based Assessment of Hypertension Epidemiology and Risk Factors among HIV-Positive and General Populations in Rural Uganda. PLoS one, 11(5), e0156309. https://doi.org/10.1371/journal.pone.0156309.

[32] Olarinde JO, Olatunji YO and Adeyemi MO (2014). Association of hypertension and obesity with HIV and antiretroviral therapy in a rural tertiary hospital in Nigeria: a cross-sectional cohort study. Vvasc Health Risk Manag, 2014;10:129-137.doi:10.2147/VHRM.S58449. PMCID: PMC3964169/PMID: 24672244.

[33] Angeli, F.; Reboldi, G.; Verdecchia, P. Hypertension around the world: New insights from developing countries. J. Hypertens. 2013, 31, 1358–1361.

[34] Zhu Z, Yan W, Yu Q, Wu P, Bingabo FM and Chen J (2022). Association between exercise and blood pressure in hypertensive residents: A meta-analysis. Evidence-Based Complementary Alternative Medicine, 2022 Jan 11;2022:2453805.doi:10.1155/2022/2453805. PMID:35069755. PMCID: PMC8767394.

[35] Rodriguez-Arboli E, Mwamelo K, Kalinjuma AV, Furrer H, Hatz C, Tanner M (2017). Incidence and risk factors for hypertension among HIV patients in rural Tanzania – a prospective cohort study.PLoS ONE 12(13):e0172089.doi: 10.1371/journal.pone.0172089.

[36] Temesgen F, Alemu GB, Henok D and Abebe Dires (2019). Hypertension in HIV-infected patients receiving antiretroviral therapy in Northeast Ethiopia. International Journal of Hypertension, vol. 2019, Article ID 4103604, 7 pages, 2019.https://doi.org/10.1155/2019/4103604.

[37] Xu Y, Chen X, Zhou Z, Morana J and Cook RL (2020). The interaction between detectable plasma viral load and increased body mass index on hypertension among persons living with HIV. AIDS Care, 32(7): 890-895.https:;;doi.org/10.1080/09540121.2019.1668521.

[38] Njelekela M, Muhihi A, Aveika A, Spiegelman D, Hawkins C, Amstrong C.... and Fawzi W (2016). Prevalence pf hypertension and its associated riskfactors among 34,111 HAART Naïve HIV-infected adults in Dar es Salaam, Tanzania. International Journal of Hypertention; 2016: 2016:5958382.doi:10.1155/2016/5958382. Epub 2016 Oct 30. PMID: 27872756; PMCID: PMC5107235.

[39] Tsuro U, Oladimeji KE, Pulido-Estrada, GA and Apalata TR (2022). Risk Factors Attributable to Hypertension among HIV-infected patients on Antiretroviral Therapybin Selected Rural Districts of the Eastern Cape Province, South African. International Journal of Enviromental Research and Public Health, 19(18), 11196. MDPI AG. http://dx.doi.org/10.3390/ijerph191811196

[40] Priscilla Y. Hisue, Steven G. Deeks and Peter W. Hunt (2012). Immunologic basis of cardiovascular diseases in HIV-infected adults. Journal of infectious diseases, vol. 205(Suppl 3):S375-S382.doi: 10.1093/infdis/jis200. PMCID: PMC3349295/PMID: 22577211.