



Research

## Prevalence of Non-Communicable Diseases among HIV Positive Patients on Antiretroviral Therapy at a Tertiary Health Facility in Makurdi, North-Central, Nigeria

<sup>1</sup>Rimamnunra GN, <sup>1</sup>Utoo PM, <sup>2</sup>Ngwoke K, <sup>3</sup>Bako IA, <sup>4</sup>Akwaras AN, <sup>4</sup>Swende LT, <sup>5</sup>Omokhua OE, <sup>1</sup>Ogbeyi GO, <sup>5</sup>Izeji RI, <sup>4</sup>Daniel DA, <sup>6</sup>Akobi MA

<sup>1</sup>Department of Epidemiology and Community Medicine, College of Health Sciences, Benue State University Makurdi, Benue State, Nigeria

<sup>2</sup>APIN Public Health Initiatives, Judges quarters, Makurdi, Benue State

<sup>3</sup>Department of Epidemiology and Community Medicine, College of Health Sciences, Federal University of Lafia, Nasarawa State, Nigeria

<sup>4</sup>Department of Family Medicine, Federal Medical Centre, Makurdi, Benue State, Nigeria

<sup>5</sup>Department of Family Medicine, Benue State University Teaching Hospital, Makurdi, Benue State, Nigeria

<sup>6</sup>ART Clinic, Benue State University Teaching Hospital, Makurdi, Benue State, Nigeria

**Corresponding author: Rimamnunra Grace Nwunuji**, Department of Epidemiology and Community Medicine, College of Health Sciences, Benue State University Makurdi, Benue State, Nigeria; [riyinrimam@gmail.com](mailto:riyinrimam@gmail.com); +2347030680151

Article history: Received 19 July 2023, Reviewed 5 September 2023, Accepted for publication 22 September 2023

### Abstract

**Background:** Human immunodeficiency virus (HIV) treatment program has grown exponentially in Nigeria largely due to improved Antiretroviral therapy (ART) regimen which has changed the course of HIV/AIDs by enabling patients to live longer, raising concern of the co-existence of HIV with other chronic illnesses, notably non-communicable diseases (NCDs). This study determined the prevalence of hypertension and diabetes mellitus among HIV positive patients in a tertiary institution in Makurdi, North-central Nigeria.

**Methods:** A cross-sectional study was conducted at the ART clinic among clients  $\geq$  aged 21 years old living with HIV /or enrolled between October 2022, and March 30, 2023. The clients' information was extracted from the register using a Proforma and all the clients who had attended their follow up clinic visit within the study period were included in the study. Data was analyzed using SPSS version 21.0. Categorical data were presented as frequencies and percentages.

**Results:** Among the 491 patients, 404 (82.3%) had HIV only and 87 (17.7%) had HIV and at least one comorbidity, namely DM and/or HTN. Hypertension was the most prevalent comorbidity affecting 15.5% of the patients while 1.0% of them were diabetic. The middle aged (30-49) patients, females (63.2%) had the highest prevalence of comorbidities and some of those with normal weight (35.6%) also had the highest prevalence of NCDs.

**Conclusion:** Non-communicable diseases are common among people living with HIV. There is need to encourage early diagnosis and treatment of non-communicable diseases in HIV positive patients in Nigeria.

**Keywords:** Diabetes mellitus, HIV, hypertension, Makurdi, Non-communicable, prevalence.

This is an open access journal and articles are distributed under the terms of the Creative Commons Attribution License (Attribution, Non-Commercial, Share Alike 4.0) - (CC BY-NC-SA 4.0) that allows others to share the work with an acknowledgement of the work's authorship and initial publication in this journal.

#### How to cite this article:

Rimamnunra GN, Utoo PM, Ngwoke K, Bako IA, Akwaras AN, Swende LT, Omokhua OE, Ogbeyi GO, Izeji RI, Daniel DA, Akobi MA; Prevalence of Non-Communicable Diseases among HIV Positive Patients on Antiretroviral Therapy at a Tertiary Health Facility in Makurdi, North-Central, Nigeria. The Nigerian Health Journal 2023; 23(3): 734 – 740.



## Introduction

Globally, there are 36.9 million people living with HIV, it is estimated that nearly 70% live in sub-Saharan Africa.<sup>1</sup> Out of the aforementioned, an estimated 1.9 million people are living with HIV (PLWHIV) in Nigeria with 74,000 new HIV infections and 51,000 AIDS-related deaths annually.<sup>2</sup> However, with many interventions, about 1.7 million people are on antiretroviral treatment with 86% viral suppression.<sup>2</sup> As a result of this, the aging group of PLWHIV raises a concern of the coexistence of HIV with other chronic illnesses, particularly the non-communicable diseases (NCDs) and their effective use of ART has led to significant increases in the survival and quality of life giving an average life expectancy increase of approximately 13 years in the western countries.<sup>3,4</sup> It was reported by WHO 2022, that NCDs are the cause of the death of 41 million people annually and 77% of these occur in low-and middle-income countries (LMICs) which are already burdened by HIV and each year, 17 million people die from a NCD before age 70.<sup>5</sup> This mortality rates might be expected to rise by 17–24% within the next decade.<sup>6</sup>

Furthermore, the NCDs which are the main focus for control globally are cardiovascular diseases (CVDs), chronic respiratory diseases, cancers and diabetes and the selected NCD risk factors also targeted for control are tobacco use, harmful alcohol use, salt intake, obesity, raised blood pressure, diabetes and physical inactivity of which PLWHIV are also involved in.<sup>7,8,9</sup> The risk of metabolic syndrome predisposing to type 2 diabetes mellitus, cardiovascular and renal diseases have been shown to increase due to HIV disease and antiretroviral therapy (ART).<sup>10</sup> In addition, other risk factors for contracting NCDs, are from the HIV infection itself, age, gender, ethnicity and socio-economic status which have also been associated with increased risk of contracting NCDs.<sup>11</sup>

Recent research in Africa, estimated the prevalence of self-reported CVD risk factors in HIV positive to be 12%.<sup>12</sup> Whereas in Nigeria, an increase in the prevalence of hypertension from 26.0% to 31.7% was reported after two years of ART.<sup>13</sup>

With the introduction of integrated care and the ideal clinic strategies, data on the burden will help in their implementation. More so, there is paucity of data on the prevalence of non-communicable disease burden among PLWHIV from early public health approaches in HIV

programming since it is a recent addition in their care package.<sup>14</sup> Therefore, this study aimed to describe the prevalence of hypertension and diabetes mellitus among HIV positive patients receiving ART in a tertiary institution (Benue state University teaching Hospital) in Makurdi, North- central Nigeria.

## Method

**Study design:** This was cross-sectional study conducted between October 2022 and March 2023. It was conducted at the commencement of NCDs screening services at the ART (Antiretroviral therapy) Clinic in Benue State University Teaching Hospital Makurdi Benue State Nigeria.

**Study site:** The study was carried out at the outpatient department, at the ART Clinic in Benue State University Teaching Hospital (BSUTH) which is a tertiary facility with 300 bed capacity located along Gboko road in Makurdi Local Government Area Benue State Nigeria. The ART Clinic is a specialized HIV care center that was established in BSUTH in 2013 to address challenges of HIV care and management in partnership with APIN public Health Initiative.

The ART clinic services in BSUTH include free anti-retroviral therapy, HIV counselling and testing services, Hypertension and Diabetes screening, Tuberculosis screening, data collection and research. Information on NCDs is collected in routine care at the facility during patient visits every six months. However other NCDs such as asthma, cardiomyopathy and osteoporosis are usually screened for when a patient complains of certain symptoms during the routine follow up visits. Renal impairment is screened for among patients upon being started ART with complaints.

**Study population:** All HIV positive patients receiving ART at BSUTH in Makurdi, Benue state Nigeria coming for enrollment or follow up within the study period.

**Inclusion criteria:** All individuals (both Male and female) aged 21 years and above newly enrolled or came for their follow up clinic visit to receive their ART and were screened for NCDs during the study period.

**Exclusion criteria:** Individuals who were unable to keep to their follow up appointments or were not screened for NCDs probably due to drug proxy pick up.

## Study variables

**Outcomes of interest:** Hypertension and diabetes mellitus. They were all treated as binary variables. An



individual was categorized as having any of these conditions or not.

**Other variables:** Demographic factors: age, sex, marital status, level of education, occupation, BMI. The BMI was obtained by dividing the individual weight by the square meter of their height and then categorized as underweight (>18.5), Normal (18.5 -25), Overweight (25 -30) or Obese (>30) based on the result. At the facility the following criterion is used to determine whether an individual has one of the above diseases:

Hypertension (HTN) according to WHO standard: If an individual is found to have a systolic blood pressure (SBP) of 140mm Hg or more, or a diastolic blood pressure (DBP) of 90 mm Hg or more or taking antihypertensive medication.

Diabetes mellitus (DM) according to WHO standard: Having a fasting blood sugar equal to or more than 140mg/dl (7.8mmol/l) on 2 or more occasions, or a Random blood sugar of more than 200mg/dl (11.8mmol/l) or having a history of diagnosis of diabetes mellitus.

**Data collection:** Research experienced personnel with bachelors in nursing and data collection staff, already working at the ART clinic in BSUTH were recruited and trained as research assistants. They were responsible for the data using a proforma. Patients presenting to the study facility for enrollment or drug re-supply, were recruited into the study.

Relevant information was then extracted from their patient files and entered into a proforma by the nurses and the data analyst. The patient files included information on a particular individual from when they were enrolled as patients at BSUTH.

**Data management:** All study data was checked for accuracy, completeness, and consistency at the end of each day by the Principal Investigator and any identified errors were corrected in real time.

Hard copies of the questionnaires were stored in a secured office and electronic data bases were kept in password protected computers. An external hard drive was used to back up the data.

Data was analyzed using SPSS version 21.0. Categorical data were presented as frequencies and percentages.

## Results

**Table1:** Socio-demographic characteristics of the participants

Variable	Frequency (N = 491)	(%)
<b>Age</b> (44 ± 11.04 years)		
18-29	48	9.8
30-49	323	65.8
50-69	118	24.0
70+	02	0.4
<b>Sex</b>		
Male	151	28.6
Female	340	71.4
<b>Morbidity</b>		
HIV only	404	82.3
HIV and DM	05	1.0
HIV and HTN	76	15.5

From table 1 above, 491 patients participated in the study. The overall mean age was 44 years (standard deviation [s.d] = 11.04) and the participants were predominantly female (71.4%) and most of the study participants (82.3%) had only HIV with no NCDs.

**Table 2:** Prevalence of NCDs in relation to Age, Gender, and BMI among the study Participants

Variables	Frequency N=87	(%)
<b>Age</b>		
18-29	1	1.2
30-49	50	57.5
50-69	33	37.9
70+	3	3.5
<b>BMI</b>		
Underweight (>18.5)	2	2.3
Normal (18.5 -25)	31	35.6
Overweight (25 -30)	26	29.9
Obesity (30<)	28	32.2
<b>NCDs</b>		
HIV & HTN	76	87.4
HIV & DM	5	5.8
HIV, HTN, DM	6	6.9

HIV-human immunodeficiency virus; DM-diabetes mellitus; HTN-hypertension.

Table 2 above showed that the young and middle-aged participants (30-49) had the highest prevalence (57.47%) of NCDs, and the female gender (63.22%) had a higher prevalence of comorbidities whereas for the body mass



index (BMI), those with normal weight had the highest prevalence of NCDs (35.63%).

## Discussion

The present study aimed to determine the prevalence of non-communicable diseases among HIV positive patients on antiretroviral therapy at a tertiary Health Facility in Makurdi, North-central, Nigeria. Among the 491 patients, 404 (82.3%) had HIV only and 87 (17.7%) had HIV and at least one comorbidity, namely DM and/or HTN. Hypertension was the most prevalent comorbidity affecting 15.5% of the patients while 1.0% of them were diabetic. The middle aged (30-49) patients, females (63.2%) had the highest prevalence of comorbidities and some of those with normal weight (35.6%) also had the highest prevalence of NCDs.

We found a hypertension prevalence of 15.5% among the study population. This finding is consistent with other studies in Africa<sup>15</sup> and outside Africa.<sup>16</sup> However, with the World Health Organization (WHO) criteria, the prevalence of HTN is 19.5% among HIV-infected persons.<sup>17</sup> Hypertension prevalence in our study is higher than the prevalence reported in Ethiopia<sup>18</sup> but lower than results of studies conducted in Northern Nigeria,<sup>19</sup> New York City<sup>20</sup> and Malaysia.<sup>21</sup>

The prevalence of Diabetes mellitus in the HIV population is rising as the major non-infectious comorbidity.<sup>22</sup> The prevalence of type 2 DM has been reported as five- to nine-fold greater in HIV-positive individuals than in HIV-negative individuals.<sup>23</sup> The prevalence of DM was 8% (95% CI: 5.5–10.5)<sup>22</sup> in the study conducted in Ethiopia, which is higher than our findings of 1.02%. The estimated prevalence of DM amongst HIV patients ranges from 2% to 14% of which this study is slightly lower than the lower limit.<sup>24</sup> Some investigators reported HIV as a risk factor for DM<sup>25, 26</sup> but others showed no association with DM.<sup>27,28</sup> Nevertheless, as PLHIV are more likely to interact with health facilities where hypertension and Diabetes screening is routine, case-finding and linkage to treatment can occur.<sup>29</sup>

Our study also found that females, aged 30-45 years, had the highest prevalence of both NCDs. This is like the findings in a study in Zimbabwe where the prevalence of comorbidity and multi-morbidity were, respectively, 15.3 % (95 % CI 13.3–17.7 %) and 4.5 % (95 % CI 3.4–6.0 %). Women had higher rates than men of both comorbidity and multi-morbidity.<sup>30</sup>

The high prevalence in women may be as a result of an underestimation in men reflecting more on their health-seeking behavior than disease prevalence itself.<sup>31, 32</sup> This study found that those within a normal range of BMI had a higher prevalence of NCDs and this differs from other studies which suggest that increased odds in females were mainly attributed to women having higher BMIs and hip to waist ratios than men and women being more physically inactive, all of which are considered risk factors.<sup>33,34</sup> Ageing has also been well described to result in gradual vascular stiffening and the prolonged use of ART particularly protease inhibitors is related to the production of vascular reactive oxygen species resulting in hypertension.<sup>35</sup>

Among PLWHIV and in the general population hypertension and DM have similar risk factors which can account for the prevalence of both NCDs in some patients: tobacco use, unhealthy diets, physical inactivity, and harmful use of alcohol. These have all been documented to be highly prevalent in some HIV positive populations,<sup>36</sup> though they were not measured in this study. ARV drug toxicities including lipodystrophy and dyslipidemias, chronic systemic inflammation, endothelial dysfunction, coagulation disorders and the virus itself are additional risk factors peculiar to HIV disease.<sup>37</sup>

Beyond the burden of NCDs in HIV positive patients, there is a gap in the knowledge of diagnosis, treatment, and outcomes of these comorbidities within developing Nations such as Nigeria, in Makurdi Local Government Area of Benue State, Nigeria. This in turn presents urgent priorities for more research.

**Strengths and Limitations:** One of the strengths of this study is that this is one of few studies to describe the prevalence of DM and HTN amongst the HIV population in a tertiary hospital setting in Makurdi LGA in Benue State Nigeria. This study had a few limitations. Due to the cross-sectional nature of the surveys, causality cannot be determined in the study population. The analysis did not account for unmeasured and unreported risk factors and other confounders that may have had an impact on the outcome variables. Also, as hypertension and diabetes were not measured or diagnostically determined, misclassification bias may have been introduced. Also, small sample population, conclusions drawn from the data need to be replicated with a larger sample size. Moreover, this study was a cross-sectional single-center study and would have been





better if the patients were followed up after the commencement of HAART especially in large multicenter studies.

**Implications of the findings:** It is imperative that health awareness and ongoing health education is conducted to highlight the NCDs risk factors and self-management of risk factors. It is important for clinicians involved in HIV care to note the importance of health education on risk factors in decreasing the incidence of NCDs. Screening for NCDs needs to be an integral part of the follow up routine care of HIV-positive patients and all patients that enter healthcare facilities.

### Conclusion

Population-based nationally representative surveys are important for developing sound health decisions and policies that would affect the country. This study identified a rising prevalence of NCDs among PLWHIV and this may help inform the development of integrated chronic disease management model to reduce the comorbid burden of disease and associated adverse health outcomes.

### Declarations

**Ethical consideration:** This was obtained from Benue State University Teaching Hospital (BSUTH) Health Research Ethics Committee (HREC) with reference BSUTH/MKD/HREC/2023/023. Participant details such as names or phone numbers were not included in the data extracted from the patient files.

**Authors' contribution:** Conceptualization (Rimamnunra GN), Methodology (Rimamnunra GN), Data collection and Analysis (Akobi MA), original draft preparation (Rimamnunra GN), review and editing (Utoo PM, Ngwoke K, Bako IA, Akwaras AN, Swende LT, Omokhua OE, Ogbeyi GO, Izeji RI, Daniel DA) Supervision (Utoo PM, Ngwoke K, Bako IA) Project administration (Rimamnunra GN and Ngwoke K), funding acquisition (Utoo PM, Ngwoke K, Akwaras AN, Swende LT, Omokhua OE, Ogbeyi GO, Izeji RI, Daniel DA). All authors read and agreed to the published version of the manuscript.

**Conflict of interest:** The authors declare that there is no conflict of interest.

**Funding:** This research received no specific grant from any funding agency.

**Acknowledgement:** Mrs Josephine Inya- ART Nurse Benue state University Teaching hospital (She assisted in data collection), Mr Gabriel Akahi-Data Analyst (Assisted in Analyzing the Data)

### References

1. UNAIDS, fact sheet 2018. UNAIDS. Accessed at <https://www.unaids.org/en/resources/documents/2018/unaids-data-2018> on the 21st of July 2023
2. Understanding the HIV epidemic. Accessed at <https://www.beintheknow.org/understanding-hiv-epidemic/data/glance-hiv-nigeria> on the 21<sup>st</sup> of June 2023
3. Haregu T.N., Oldenberg B, Setswe G, Elliot J, Nanayakkara V. Epidemiology of Comorbidity of HIV/AIDS and Non-Communicable Diseases in Developing Countries: A systematic review. 2012; 2(1) 1-13
4. Antiretroviral Therapy Cohort Collaboration. Life expectancy of individuals on combination antiretroviral therapy in high-income countries: a collaborative analysis of 14 cohort studies. The Lancet. 2008;372(9635):293–299.
5. WHO, Non-communicable diseases, Accessed at <https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases> on the 21st of July 2023
6. Non-Communicable Diseases Deemed Development Challenge of 'Epidemic Proportions' in Political Declaration Adopted During Landmark General Assembly Summit. (2011) United Nations. Department of Public Information. Accessed at <https://press.un.org/en/2011/ga11138.doc.htm> on the 21<sup>st</sup> July 2023
7. Kontis V, Mathers CD, Rehm J, Stevens GA, Shield KD, Bonita R et al. Contribution of six risk factors to achieving the 25× 25 non-communicable disease mortality reduction target: a modelling study. Lancet. 2014; 384:427–437.
8. Alleyne G, Binagwaho A, Haines A, Jahan S, Nugent R, Rojhani A, Stuckler D, Lancet NCD. Action Group. Embedding non-communicable diseases in the post-2015 development agenda. The Lancet. 2013;381(9866):566–574.
9. Bonita R, Magnusson R, Bovet P, Zhao D, Malta DC, Geneau R, Suh I, Thankappan KR, McKee M, Hospedales J, De Courten M. Country actions to meet UN commitments on non-communicable diseases: a



- STEPwise approach. *The Lancet*. 2013;381(9866):575–84.
10. Van Wijk JP, Cabezas MC. Hypertriglyceridemia, metabolic syndrome, and cardiovascular disease in HIV-infected patients: effects of antiretroviral therapy and adipose tissue distribution. *International Journal of Vascular Medicine*. 2012; 2012:1–13
  11. Abebe SM, Getachew A, Fasika S, Bayisa M, Girma Demisse A, Mesfin N. Diabetes mellitus among HIV-infected individuals in follow-up care at University of Gondar Hospital, Northwest Ethiopia. *BMJ Open*. 2016;6(8):e011175. 10.1136/bmjopen-2016-011175
  12. Sherer R, Solomon S, Schechter M, Nachega JB, Rockstroh J, Zuniga JM. HIV provider-patient communication regarding cardiovascular risk: results from the AIDS Treatment for Life International Survey. *J Int Assoc Provid AIDS Care*. 2014;13(4):342–345.
  13. Denué BA, Muazu PJ, Gashau W, Nkami D, Ajayi NA. Effects of highly active antiretroviral therapy (HAART) on blood pressure changes and its associated factors in HAART naive HIV-infected patients in northeastern Nigeria. *Arch Appl Sci Res*. 2012;4(3):1447-1452.
  14. WHO. Consolidated Guidelines on the use of Antiretroviral Drugs for Treating and Preventing HIV Infection Recommendations for A Public Health Approach. 2013. Accessed at <https://www.ncbi.nlm.nih.gov/books/NBK374294/> on the 26<sup>th</sup> of June 2023
  15. Dalsone K, Laura B, David H, et al. Population-based assessment of hypertension epidemiology and risk factors among HIV-positive and general populations in rural Uganda. *PLoS One*. 2016;11(5): e0156309
  16. Baekken M, Os I, Sandvik L, Oektedalen O. Hypertension in an urban HIV-positive population compared with the general population: influence of combination antiretroviral therapy. *J Hypertens*. 2008;26(11):2126–2133.
  17. Ataro Z, Ashenafi W, Fayera J, Abdosh T. Magnitude and associated factors of diabetes mellitus and hypertension among adult HIV-positive individuals receiving highly active antiretroviral therapy at Jugal Hospital, Harar, Ethiopia. *Hiv Aids (Auckl)*. 2018; 10:181–192.
  18. Isa SE, Kang'ombe AR, Simji GS, Shehu NY, Oche AO, Idoko JA, 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.
  19. Merle M, Eduard P, Ehrin A, Shari K, Victoria S, Heejung B. Prevalence, Treatment, and Control of Dyslipidemia and Hypertension in 4278 HIV Outpatients. *J Acquir Immune Defic Syndr*. 2014;66(4):370–377.
  20. Hejazi N, Huang MSL, Lin KG, Choong LCK. Hypertension among HIV-infected adults receiving highly active antiretroviral therapy (HAART) in Malaysia. *Glob J Health Sci*. 2013;6(2):58–71.
  21. Abebe SM, Getachew A, Fasika S, Bayisa M, Girma Demisse A, Mesfin N. Diabetes mellitus among HIV-infected individuals in follow-up care at University of Gondar Hospital, Northwest Ethiopia. *BMJ Open*. 2016;6(8):e011175. 10.1136/bmjopen-2016-011175
  22. Samaras K, Wand H, Law M, Emery S, Cooper D, Carr A. Prevalence of metabolic syndrome in HIV-infected patients receiving highly active antiretroviral therapy using International Diabetes Foundation and Adult Treatment Panel III criteria: Associations with insulin resistance, disturbed body fat compartmentalization, elevated C-reactive protein, and [corrected] hypoadiponectinemia. *Diabetes Care* 2007;30(1):113–119.
  23. Monroe AK, Glesby MJ, Brown TT. Diagnosing and managing diabetes in HIV-infected patients: Current concepts. *Clin Infect Dis*. 2014;60(3):453–462.
  24. Galli L, Salpietro S, Pellicciotta G, et al. Risk of type 2 diabetes among HIV-infected and healthy subjects in Italy. *Eur J Epidemiol*. 2012;27(8):657–665.
  25. Noubissi EC, Katte JC, Sobngwi E. Diabetes and HIV. *Curr Diab Rep*. 2018;18(11):125. 10.1007/s11892-018-1076-3
  26. Rasmussen LD, Mathiesen ER, Kronborg G, Pedersen C, Gerstoft J, Obel N. Risk of diabetes mellitus in persons with and without HIV: A Danish nationwide population-based cohort study. *PLoS One*. 2012;7:e44575. 10.1371
  27. Butt AA, McGinnis K, Rodriguez-Barradas MC, et al. HIV infection and the risk of diabetes mellitus. *AIDS (London, England)*. 2009;23(10):1227–1234.
  28. Knowledge Translation Unit UoCTLI. Adult primary care guide (APC) 2019/2020. Pretoria: The National Department of Health of South Africa; 2019 Accessed at <https://knowledgehub.health.gov.za/elibary/adult-primary-care-apc-guide-20192020-updated> on the 15<sup>th</sup> of June 2023
  29. Magodoro IM, Esterhuizen TM, Chivese T. A cross-sectional, facility base study of comorbid non-communicable diseases among adults living with HIV infection in Zimbabwe. *BMC Res Notes*. 2016; 9:379.
  30. Kwarisiima D, Balzer L, Heller D, Kotwani P, Chamie G, Clark T, et al. Population-Based Assessment of



- Hypertension Epidemiology and Risk Factors among HIV-Positive and General Populations in Rural Uganda. *PLoS One*. 2016;11(5):e0156309.
31. Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, et al. The south African National Health and nutrition examination survey, 2012: SANHANES-1: the health and nutritional status of the nation. 2014.
  32. Zungu NP, Mabaso ML, Kumalo F, Sigida S, Mlangeni L, Wabiri N, et al. Prevalence of non-communicable diseases (NCDs) and associated factors among HIV positive educators: findings from the 2015/6 survey of health of educators in public schools in South Africa. *PLoS One*. 2019;14(2):e0209756.
  33. Antonello VS, Carlos Ferreira Antonello I, Grossmann TK, Tovo CV, Brasil dal Pupo B, de Quadros Winckler L. hypertension—an emerging cardiovascular risk factor in HIV infection. *J Am Soc Hypertens*. 2015;9(5):403–407.
  34. Petrie JR, Guzik TJ, Touyz RM. Diabetes, hypertension, and cardiovascular disease: clinical insights and vascular mechanisms. *Can J Cardiol*. 2018;34(5):575–584.
  35. Friis-Moller N, Weber R, Reiss P, Thiebaut R, Kirk O, d'Arminio Monforte A, et al. Cardiovascular disease risk factors in HIV patients: association with antiretroviral therapy. Results from the DAD study. *AIDS*. 2003; 17:1179–1193.
  36. Lipshultz SE, Mas CM, Henkel JM, Franco VI, Fisher SD, Miller TL. HAART to heart: highly active antiretroviral therapy and the risk of cardiovascular disease in HIV-infected or exposed children and adults. *Expert Rev Anti Infect Ther*. 2012;10: 661–674.