Correlates of Hypertension among Persons with HIV at Livingstone Central Hospital: CHAP study

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Abstract

Background: Persons with HIV (PWH) are more likely to develop hypertension and cardiovascular disease than the HIV-negative population. The new hypertension guidelines by the American Heart Association (AHA) and the American College of Cardiology (ACC) lowered the definition of hypertension from a systolic and diastolic blood pressure (BP) of $\geq 140/90$ mmHg to $\geq 130/80$, respectively. This study was aimed at determining the prevalence and factors associated with hypertension in PWH using the new hypertension diagnostic criteria.

Methods: This was a cross-sectional study. We recruited 226 antiretroviral treated PWH attending routine visits. Socio-demographic, health, and clinical data including BP readings were collected. Interviewer-structured questionnaires adapted from the World Health Organization Stepwise approach to Surveillance (WHO STEPs) and the international physical activity questionnaire (IPAQ) were used to collect data. Statistical evaluations were employed to elucidate relationships between hypertension and all response variables.

Results: The prevalence of hypertension using the old and new guidelines was 16% and 42%, respectively. Factors significantly associated with increased and reduced odds for developing hypertension after adjustments in multivariate logistic regression were age, body mass index (BMI), employment status, fasting blood sugar (FBS) and table salt consumption, respectively ($p < 0.05$ for all). Using the new AHA/ACC criteria for hypertension shifted the prevalence from 16% (old criteria) to 42%.

Conclusion: The major risk factors associated with hypertension in PWH were increasing age, BMI and FBS. We recommend inclusion of FBS in routine measurements in PWH. The AHA/ACC new guidelines should be re-enforced in low-cost settings to increase the treatment of hypertension among PWH.

Introduction

Susceptibility to non-communicable diseases (NCDs), such as hypertension, is a rising challenge facing persons with HIV (PWH), especially in low-income countries [1]. Collection of comprehensive baseline information that elucidates the underlying health risk factors associated with hypertension are critical for patient quality care, identification, and management of associated cardiovascular risk factors [1, 2]. Many of the risk factors can be measured during routine clinic visits. This is of particular importance in sub-Saharan Africa where the burden of NCDs is high in PWH [3].

In 2017, a report on clinical practice guidelines from the American College of Cardiology (ACC) and the American Heart Association (AHA) Task Force was released to aid in hypertension diagnosis and management [4]. For many years, systolic and diastolic blood pressure (SBP/DBP) categories of below 120/80 mmHg, 120-139/80-89 mmHg and 140/90 mmHg or higher defined normal, pre-hypertension and hypertension, respectively [5]. However, according to the new classification, the SBP/DBP reading categories of below 120/80 mmHg, 120-129/<80 mmHg and 130/80 mmHg or higher define normal, elevated blood pressure (BP) and hypertension [4]. Furthermore, the new guidelines also provide new

treatment recommendations, including lifestyle changes to manage elevated blood pressure and hypertension [4]. Among lifestyle and social-economic factors pertinent to hypertension management are diet, smoking, physical inactivity, being divorced/widowed, and lower education [6–8]. However, data based on new hypertension guidelines that reports on the prevalence and factors associated with hypertension among PWH living in sub-Saharan Africa is scarce.

We conducted a cross-sectional analytical study to determine the prevalence and risk factors associated with hypertension in PWH. Furthermore, focusing on Zambia's health care, we were seeking to provide epidemiological data and compare these data to those collected in other countries. The study aims included: 1. To determine the prevalence of hypertension in PWH in Zambia using the new AHA/ACC guidelines; 2. To determine routinely- and non-routinely collected factors associated with hypertension in PWH.

Methods

Study design and Setting

We conducted a cross-sectional analytical study at Livingstone Central Hospital (LCH), the largest referral hospital (and hosting the largest ART clinic) in the Southern Province of Zambia. The antiretroviral therapy (ART) offers ART and general medical services to the community, with approximately 3,800 PWH enrolled in ART.

Participants

Participants were enrolled from the ART clinic during their regular attendance to these services.

Eligibility criteria

We included all adults aged 18 years and above living with HIV. Study participants were only recruited after verbally consenting and signing a consent form. We excluded patients seeking healthcare due to an acute illness rather than routine ART clinic reviews and participants who were currently taking antihypertensive medication for purposes of BP classification. Participants with history of antihypertensive medication but who had not taken their medication for ≥ 2 weeks were included in the study and classified as hypertensive.

Sample size estimation

We used OpenEpi online software (sample size for a proportion or descriptive study) to compute a total sample size of 226 using an estimated prevalence of hypertension of 19.3% (local quarterly monthly records) at 95% significance level and 80% power in an ART population of 3776. The formula is stipulated below:

Sample size (n) = $[(DEFF * N * p(1-p))] / [(d^2 / Z^2 * 1 - \alpha / 2 * (N - 1) + p * (1 - p))]$; where N is the population size; p is hypothesized % frequency of outcome factor in the population; d is Confidence limits as % of 100 (absolute +/- %, which is 5%); DEFF is the design effect.

Study variables

The primary response variable was hypertension. The diagnosis of hypertension for participants was initially based on history of antihypertensive usage and BP readings of 140/90 mmHg or higher according to the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7)[5]. However, in this study, we used the new AHA/ACC criteria for hypertension as a BP reading of 130/80 mmHg or higher [4].

Explanatory variables included:

Social demographic characteristics such as age, gender, marital status, employment status, highest education attained.

Physical activities and dietary lifestyle: daily physical activity, minutes of weekly vigorous and moderate activity, minutes of weekly walking activity, minutes spent seated every weekend and weekday, days per week with fruit intake, days per week with vegetable intake, the addition of salt at the table and while cooking, processed salt intake (intake of salt from processed foods), current alcohol consumption, current or past smoker.

Clinical factors: BMI (weight in kg/height in meters²), waist circumference, duration on ART, ART regimen, use of antihypertensive medication, pulse, pulse pressure [defined as systolic BP (SBP) minus diastolic BP (DBP)], mean arterial pressure (MAP) (defined as DBP plus one third pulse pressure), mid-BP (sum of SBP and DBP, divided by 2), CD4 counts, HIV RNA viral load, fasting blood sugar (FBS), diabetes risk scores, diabetes risk category. Diabetes risk scores were calculated using the International Diabetes Federation (IDF) risk assessment form as previously described elsewhere [9].

BP measurements

We used the WGNBPA 730 (USA) and SBM 67 (Germany) BP monitors for measurements. For standard measurements, we adapted the new AHA/ACC guidelines [4]: The patients had not been exercising, smoking, or drinking caffeine, their bladders were empty, and they were seated for more than 30 minutes before measurements were taken in a still position. The limb used to measure BP was supported ensuring that the BP cuff was at heart level. During the measurements, the participants were asked to sit upright, back straight, with feet flat on the floor without legs crossing each other. Three readings were taken and averaged. The average BP was used to reflect the person's BP. Routine BPs taken by attending nurses did not take into account the consideration explained above. Furthermore, our measured BP values were compared to the BP measurements taken by attending nurses during routine visits as reported in the patients' health records.

Hypertension diagnosis was based on history of antihypertensive drugs (where hypertensive patients did not take antihypertensive drugs for ≥ 2 weeks to satisfy the eligibility criteria) except for four participants where we used BP readings taken on 2 or more occasions (from records) which were consistent with the standard measurements we took. New diagnosis of hypertension using the AHA criteria for participants with no history of antihypertensive medication usage was based on BP readings taken on 2 occasions.

Antihypertensives

Most participants with a history (≥ 2 weeks) of using antihypertensive medication were using two antihypertensive drugs, a calcium channel blocker (Amlodipine or Nifedipine) and an Angiotensin-converting enzyme inhibitor (ACE) (Enalapril or Losartan) or a Diuretic (Furosemide or Moduretic).

Data sources/ measurement

For data collection, we used the interviewer structured questionnaire adapted from the WHO STEPs (World Health organization's STEPwise Approach to Surveillance), the international physical activity questionnaire (IPAQ), and the IDF type 2 diabetes risk assessment forms described in our previous study [9]. These were translated into the local language (Tonga) for participants that could not speak English.

Data analysis

Since data were not normally distributed (p value <0.05 , Shapiro-wilk's test for all continuous variables categorized by hypertension status), we used the non-parametric test Mann-Whitney to compare medians (interquartile range) of continuous variables between normotensives and hypertensives. For categorical variables, we used Chi-square or fishers' exact test where appropriate. We selected known risk factors for developing hypertension and variables significant in univariate logistic regression were included in the multivariate logistic regression model. We reported odds ratios (OR), adjusted odds ratios (AOR), and confidence limits at 95%. We used descriptive statistics to compare the proportion of participants in each BP category and hypertension status between JNC 7 and the new AHA/ACC criteria. To compare routine BP measurements taken by attending nurses and standard BP measurements, we used Mann-Whitney and non-parametric Spearman correlation coefficient to assess the strength of association. We also reported median differences and their confidence limits (95%).

Age, WC, BMI, and diabetes risk were also categorized to ease interpretation. P values less than 0.05 were considered significant and are shown in bold. We used SPSS statistical software for data analysis.

Results

General characteristics of participants

We found that the prevalence of hypertension in the study population was 42% as determined using the new AHA/ACC criteria and 16% as determined using the JNC 7 criteria (see Table 1). The age range was 18 to 88 years old and 66% female (n, 149)

Table 1. Social-demographic characteristics associated with hypertension

Variables	Normotensive n(%) 131 (58.0)	Hypertensive n(%), 95 (42.0%)	P value
Hypertension status based on old criteria			
Normotensive, <i>n/total (%)</i> <i>191/226 (85.5%)</i>	131 (100)	60 (63.2)	<0.001
Hypertensive, <i>n/total (%)</i> <i>35/226 (15.5%)</i>	0 (0.0)	35 (36.8)	
Age, median years (IQR)	40 (30, 46)	50 (42, 57)	<0.001
Age category (years)			
<i>18 - 35</i>	49 (37.4)	8 (8.4)	<0.001
<i>36 - 45</i>	45 (34.4)	28 (29.5)	
<i>46 - 55</i>	30 (22.9)	30 (31.6)	
<i>56 - 65</i>	6 (4.6)	25 (26.3)	
<i>66 - 90</i>	1 (0.8)	4 (4.2)	
Gender, n(%)			
Female	89 (67.9)	60 (63.2)	0.454
Male	42 (32.1)	35 (36.8)	
Marital status			
<i>Married</i>	57 (43.5)	44 (46.3)	0.001
<i>Widowed</i>	26 (19.8)	37 (38.9)	
<i>Single</i>	38 (29.0)	11 (11.6)	
<i>Divorced</i>	10 (7.6)	3 (3.2)	
Employment Status			
<i>GRZ/Private</i>	28 (21.4)	30 (31.6)	<0.001
<i>Self employed</i>	51 (38.9)	24 (25.3)	
<i>Retired</i>	3 (2.3)	17 (17.9)	
<i>Unemployed</i>	49 (37.4)	24 (25.3)	
Highest Education attained			
<i>No formal education</i>	5 (3.8)	4 (4.2)	0.339

<i>Primary</i>	28 (21.4)	20 (21.1)
<i>Secondary</i>	76 (58.0)	46 (48.4)
<i>Tertiary</i>	22 (16.8)	25 (26.3)

IQR, interquartile range; GRZ, government; n, number of participants; %, percentage

Socio-demographic variables associated with hypertension

Age (Fig 1A), Age category (Fig 1B), marital (Fig 2A) and employment status (Fig 2B) were associated with hypertension ($p<0.01$) as shown in Table 1.

Lifestyle factors associated with hypertension

Minutes of weekly walking activity ($p=0.006$) and addition of salt while cooking ($p=0.001$) were the only factors associated with hypertension, Table 2.

Table 2. Dietary and lifestyle factors associated with Hypertension

Variables	Normotensive n(%) 131 (58.0)	Hypertensive n(%), 95 (42.0%)	P value
Daily physical activity			
Yes	69 (52.7)	35 (36.8)	0.018
No	62 (47.3)	60 (63.2)	
Minutes of Weekly vigorous activity, <i>median (IQR)</i>	0 (0, 120)	0 (0, 120)	0.893
Minutes of Weekly moderate activity, <i>median (IQR)</i>	60 (30, 180)	20 (0, 120)	0.172
Minutes of Weekly walking activity, <i>median (IQR)</i>	55 (23, 120)	60 (20, 120)	0.221
Minutes spent seated every weekend, <i>median (IQR)</i>	300 (120, 383)	300 (180, 420)	0.327
Minutes spend seated every weekday, <i>median (IQR)</i>	180 (120, 360)	240 (120, 360)	0.257
Days per week with fruit intake, <i>median (IQR)</i>	1 (0, 2)	1 (0, 3)	0.490
Days per week with vegetable intake, <i>median (IQR)</i>	7 (5, 7)	7 (7, 7)	0.429
Addition of salt at the table			
Never or rarely	42 (32.1)	11 (11.6)	<0.001
Sometimes or always	89 (67.9)	84 (88.4)	
Addition of salt while cooking			
Never	0 (0.0)	1 (1.1)	0.108
Sometimes	1 (0.8)	4 (4.2)	
always	130 (99.2)	90 (94.7)	
Processed salt intake			
Never	21 (16.0)	26 (27.4)	0.027
Rarely	26 (19.8)	25 (26.3)	
Sometimes	74 (56.5)	42 (44.2)	
always	10 (7.6)	2 (2.1)	
Alcohol consumption			

No	98 (74.8)	81 (85.3)	0.056
Yes	33 (25.2)	14 (14.7)	
Current or past smoker			
No	113 (86.3)	81 (85.3)	0.832
Yes	18 (13.7)	14 (14.7)	

IQR, interquartile range

Clinical factors associated with hypertension

BMI (Fig 3A), BMI category (Fig 3B), WC (Fig 4A), WC category (Fig 4B), duration on ART (Fig 5A), fasting blood sugar (Fig 5B), diabetes risk scores (Fig 5C), diabetes risk category (Fig 6), pulse pressure, mean arterial pressure, and mid-BP, were associated with hypertension, $p < 0.05$ (Table 3). There was no specific ART regimen that was associated with hypertension. Pulse, CD4 count, and HIV RNA viral load were analogous between hypertensives and normotensive, $p > 0.05$.

Multivariate analysis of factors associated with hypertension

We included all factors associated with hypertension in logistic regression in multivariate analysis. Age, BMI, employment status, table salt consumption (inversely association), and fasting blood sugar remained significantly associated with hypertension after adjustments, as shown in Table 4.

Table 4. Factors associated with hypertension in logistic regression

Variable	Odds Ratio (OR) (95%CI)	p-value	Adjusted Odds Ratio AOR (95%CI)	p-value
Sex				
<i>Female</i>	1		1	
<i>Male</i>	1.24 (0.71, 2.15)	0.454	1.14 (0.29, 4.48)	0.850
Age, <i>Years</i>	1.09 (1.06, 1.13)	<0.001	1.08 (1.03, 1.15)	0.004
Body mass index, <i>kg/m²</i>				
<i><18.5</i>	1		1	
<i>18.5 – 24.9</i>	1.97 (0.79, 4.95)	0.145	5.17 (0.96, 27.91)	0.056
<i>25.0 – 29.9</i>	4.76 (1.68, 13.43)	0.003	8.60 (1.07, 69.35)	0.043
<i>≥30</i>	5.61 (1.81, 17.32)	0.003	23.36 (1.44, 446.46)	0.027
Waist circumference category, <i>cm</i>				
<i><94 men or < 80 women</i>	1		1	
<i>94-102 men or 80-88 women</i>	2.07 (1.01, 4.28)	0.048	0.56 (0.13, 2.48)	0.443
<i>>102 men or >88 women</i>	4.24 (2.13, 8.44)	<0.001	1.99 (0.27, 14.81)	0.503
Employment Status				
<i>GRZ/Private</i>	1		1	
<i>Self employed</i>	0.44 (0.22, 0.89)	0.023	0.33 (0.09, 1.23)	0.100
<i>Retired</i>	5.28 (1.39, 20.01)	0.014	2.37 (0.26, 21.18)	0.442
<i>Unemployed</i>	0.45 (0.22, 0.93)	0.031	0.19 (0.04, 0.95)	0.043
Minutes of moderate physical activity	1.00 (0.99, 1.00)	0.973	0.99 (0.99, 1.00)	0.218
Sedentary hours (sitting)	1.00 (1.00, 1.01)	0.129	1.00 (0.99, 1.00)	0.148
Smoking status				
<i>No</i>	1		1	
<i>Yes</i>	0.92 (0.43, 1.96)	0.832	1.99 (0.43, 9.30)	0.382
Table salt consumption				
<i>Never or rarely</i>	1		1	
<i>Sometimes or always</i>	0.27 (0.13, 0.57)	0.001	0.17 (0.04, 0.95)	0.022
Alcohol consumption				

No	1		1	
Yes	1.94 (0.97, 3.88)	0.059	3.54 (0.97, 12.87)	0.055
Fasting blood sugar, <i>mmol/l</i>	2.01 (1.28, 3.36)	0.003	2.07 (1.04, 4.13)	0.038
Duration on ART	1.01 (1.00, 1.01)	0.033	1.01 (1.00, 1.02)	0.05

ART, antiretroviral therapy; GRZ, government

Comparison of the JNC 7 and AHA/ACC diagnostic criteria for hypertension

We compared the classification of the patients in our study using the JNC 7 and AHA criteria. We found that by using the new AHA/ACC criteria, 26% more normotensive individuals (based on the JNC 7 criteria) were classified as hypertensive (Table 5).

Table 5. Comparison of Blood pressure categories and status between JNC 7 and new AHA/ACC criteria

Category BP with JNC 7 criteria	n(%)	Category BP with New ACC/AHA criteria	n(%)	Difference
BP categories		BP categories		
Normal	94 (41.6)	Normal	84 (37.2)	10 (4.4)
Prehypertension	45 (19.9)	Elevated	47 (20.8)	-2 (-0.9)
Stage 1 hypertension	25 (11.1)	Stage 1 hypertension	31 (13.7)	-6 (-2.6)
Stage 2 hypertension	62 (27.4)	Stage 2 hypertension	64 (28.3)	-2 (-0.9)
Hypertension Status		Hypertension Status		
Normotensive	191 (84.5)	Normotensive	131 (58)	60 (26.5)
Hypertensive	35 (15.5)	Hypertensive	95 (42)	-60 (-26.5)
Total	226 (100)	Total	226 (100)	
AHA, American heart association; ACC, American college of cardiology; BP, blood pressure; JNC 7, Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure				

Comparison of routine versus standard measurements

BP readings obtained by one measurement taken by attending nurses (routine) compared to three averaged measurements re-taken by the researchers using standard guidelines were significantly different. Systolic, diastolic BPs and pulse routine measurements were significantly higher when taken during routine visits than our standard measurements (Fig 7, $p<0.0001$), with a strong positive correlation (Table 6). Based on one measurement taken by attending nurses, 4% and 12% of participants would have been misclassified as hypertensive using the JNC 7 and new AHA/ACC criteria, respectively, Table 6.

Table 6. Nurse BP measurement versus three averaged standard BP measurements

Variable	Nurses reading Median (IQR)	Standard measurement Median (IQR)	Median of difference 95% CI	rho	p-value
Systolic Blood pressure, <i>mmHg</i>	128 (115,144)	124 (113,141)	3 (1,5)	0.8	<0.0001
Diastolic blood pressure, <i>mmHg</i>	83 (75, 94)	80 (71, 89)	3 (1, 5)	0.7	<0.0001
Pulse, <i>beats per minute</i>	78 (69, 86)	72 (62, 80)	4 (2, 4)	0.7	<0.0001
Misclassified hypertensive using JNC 7 criteria, <i>n/total NT (%)</i>	7 /191 (3.7)				
Misclassified hypertensive using new AHA/ACC criteria, <i>n/total NT (%)</i>	23/191 (12.0)				
Rho, nonparametric Spearman correlation coefficient; NT, normotensive					

Discussion

The aim of this study was to determine the prevalence and factors associated with hypertension in PWH based on the new hypertension diagnostic criteria.

Prevalence of hypertension

While using the JNC 7 criteria puts the prevalence of hypertension in our study at 16%, the new AHA/ACC criterion shifts the prevalence to 42% representing a 26% shift of those previously considered normotensive into the hypertensive category. The reported prevalence of hypertension in PWH in low- and middle-income countries ranges from 4 to 54% [10, 11]. In ART-treated PWH, a prevalence of hypertension of between 17 to 38% has been reported [12–15] using the JNC 7 criteria, lower than what we reported. However, with the new AHA/ACC criteria, our results indicate an urgent need for intervention. However, further investigations are required to understand the outcomes of hypertension in PWH when using the

new hypertension guidelines as previous studies of cardiovascular events, stroke, etc relied on different definitions of hypertension. So we do not know whether the new guidelines will improve the prior epidemiological models.

Factors associated with hypertension in PWH

Among the social-demographic data collected, three were positively associated with hypertension, including the age of participants, employment status and marital status. In the Zambian setting, the patients' age is always recorded, while the rest are non-routine data. The new AHA/ACC does not recommend consideration for employment status, marital status, or level of education when assessing risk for hypertension or treatment. However, most hypertensives in this study were married (46% hypertensive versus 43% normotensive), and in formal employment (31% hypertensive versus 21% normotensive). Furthermore, the JNC 7 and AHA/ACC does not consider the influence of these factors on blood pressure. Here, we suggest that further studies are needed to determine how an individual's employment status, marital status, and level of education relate to hypertension in low-income countries.

Among dietary and lifestyle non-routinely collected variables, factors such as daily physical activity, the addition of salt at the table, and processed salt intake (negative association) were all positively associated with hypertension (Table 2), and this is in tandem with the recent hypertension report guidelines [4].

The clinical factors associated with hypertension included BMI, WC, duration on ART, pulse pressure, MAP, mid-BP, FBS, diabetes risk scores, and risk category (Table 3). Among these, only BMI is routinely collected in Zambian hospitals. While BP components such as pulse pressure, MAP, and mid-BP are expected to be different between hypertensive and normotensive, we only included these variables in the analysis to indirectly assess the effect of antihypertensive drugs. It is expected that hypertensive patients taking antihypertensives will present with BP readings similar or lower than those of normotensive individuals except when either the patient has hypertension that does not respond to the current treatment or due to poor adherence to the hypertension medication. We found in our study that PP, MAP, and mid-BPs were higher in hypertensive patients. This is because all hypertensives in the study had not taken their medication for more than two weeks. Since we did not collect data on adherence to antihypertensive drugs and cannot ascertain the cause for this.

Hypertensive patients had high diabetes risk scores and FBS (Table 3). Often the factors associated with hypertension are likely related to diabetes risk too [16]. Hence, we employed a diabetes risk assessment tool to assess if hypertensive patients were at risk of developing diabetes mellitus type 2 in 10 years. The value for diabetes risk assessment scores has been described from our recent previous study conducted in PWH [9]. Conducting diabetes risk assessment would be cardinal among PWH let alone hypertensive.

We performed a multivariate logistic regression to assess each variable's contribution towards hypertension status (Table 4). Being older [1.0 (1.03, 1.15); AOR 95%CI] was positively associated with hypertension in HIV while those who were overweight (BMI =25-29.9) and obese (BMI equal to or greater

than 30) were eight ($p=0.043$) and twenty-three ($p=0.027$) times more likely to be hypertensive, respectively. These findings are consistent with another study conducted locally in Zambia [17] and other studies reviewed [4]. Fasting blood sugar was positively associated with hypertension ($p=0.038$) as those with higher fasting blood sugars were twice more likely to be hypertensive (1.0, 4.1, 95% CI). Being unemployed had reduced effect on hypertension [0.19 (0.04, 0.95); AOR 95% CI]. Unexpectedly, those who added salt on the table had reduced odds [0.17 (0.04, 0.95; AOR, 95%)] for developing hypertension compared to those who rarely or never add salt on the table. These results were contrary to a study conducted in neighbouring Zimbabwe, where adding salt to food at the table (AOR 2.77, 95% CI 1.41–5.43) was an independent risk factor for uncontrolled hypertension. However, the study population was not PWH. In our study, we did not quantify the amount of salt the participants consumed. Hence, further studies are needed to ascertain the role of table salt as a risk factor for hypertension in PWH. Several studies consistently report that higher salt intake is positively associated with BP and hypertension [18–20], albeit not in PWH. A previous study reported that among the Zambian population, salt consumption was more than twice that recommended by WHO [19]. There is a general paucity of studies and no study known to us that has addressed salt intake and its relation to BP and hypertension in HIV. There is also the issue of salt sensitivity which varies among individuals [21, 22]. However, our study was beyond the scope of assessing actual salt quantities and sensitivity.

Compared to those with normal WC (<94 cm men; <88 cm women), individuals with a WC between 94–102 for men and 80 to 88 for females and those with a WC above 102 for men and above 88 for females were sixteen times (1.2, 198.9; 95% CI) and 290 times respectively, more likely to be hypertensive ($p<0.05$). Individuals with more extended sedentary lifestyles, which is the amount of time spent seated, were more likely to be hypertensive [1.0 (1.00, 1.01); AOR, 95%CI, $p=0.021$] while minutes of moderate physical activity were associated with lower risk of being hypertensive [0.98 (0.97, 1.00) 95%CI, $p=0.048$]. These results are consistent with previous studies and the AHA/ACC report on hypertension [4]. Our results provide evidence that several non-routinely collected variables should be incorporated in routine ART services and care to prevent hypertension and its attendant adverse outcomes.

Contextualizing the usage of new AHA/ACC guidelines in low-cost settings in PWH

The treatment and care of PWH previously overlooked the burden of NCD comorbidity such as hypertension. Recently (2018), the Zambian government, through the Ministry of Health integrated hypertension management in PWH (see www.hivst.org). However, the guidelines are not detailed and lack the most critical hypertension diagnosis, treatment, and care emphasized in the new AHA/ACC criteria.

We found in this study that the current routine practice for the measurement of BP in PWH may not be accurate. As shown in Table 6, routine measurements that did not take into consideration the preparation of the patient, such as resting, sitting position, and taking more than one BP measurement, resulted in higher BPs than the standard measurement with median SBP and SDP differences of 3mmHg. As a result, about 4% (7/191) and 12% (23/191) of normotensives would have been misclassified as hypertensive using the JNC 7 and new AHA/ACC diagnostic criteria. All measurement guidelines

stipulated in the new AHA/ACC guidelines can be implemented in low-cost settings. Self-monitoring of BP is also encouraged to enhance accuracy in BP measurements and to avoid white coat hypertension.

Using the new AHA/ACC criteria to diagnose hypertension shifted 26% of normotensives into hypertension (Table 5). This is consistent with the AHA/ACC report [4]. The advantage of this is that most of the patients can prevent hypertension-related health complications through lifestyle changes alone, such as reducing salt intake, increased physical activity, reducing sedentary time, and eating more plant-based diets [4, 23, 24]. These changes are feasible in low-cost settings and can potentially reduce the burden and complications of hypertension.

The 10-year risk for heart disease and stroke using the atherosclerotic cardiovascular disease (ASCVD) risk calculator elaborated in the new AHA/ACC guidelines is uncommon in Zambia and SSA countries. ASCVD risk components include age, sex, race, SBP, DBP, total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, history of diabetes, smoking status, antihypertensive drug history, history of statin use, and aspirin use. Screening for ASCVD in low-cost settings is feasible, although testing for LDL and HDL is not yet routine at Livingstone Central Hospital.

Our study shows that the new AHA/ACC guidelines are needed. We would, therefore, encourage integrating the guidelines into routine care for PWH.

Limitations

We did not collect data on drug adherence to antihypertensive medications to ascertain the cause of uncontrolled BPs in hypertensive patients. Further, we did not have a comparison group (HIV negative) to ascertain the effect of HIV and ART on hypertension and factors related to hypertension.

Conclusion

The prevalence of hypertension in PWH using the previous JNC 7 and new AHA/ACC criteria was 15.5% and 42%, respectively. A significant number of non-routinely collected variables (employment status, dietary salt, fasting blood sugar, physical activity, sedentary hours) were associated with hypertension; hence, there is much need for intensifying monitoring and incorporating additional modifiable non-routine risk factors for hypertension in HIV care. The new AHA/ACC guidelines are indispensable and critical for care, hence the urgent need to integrate them in managing hypertension, especially among PWH.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC) (Assurance No. FWA00000338 IRB00001131 of IORG0000774) on 24th May 2017. Permission to conduct the study was granted by the Livingstone Central Hospital Administration. All

participants were asked to consent by signing a consent form before being included in the study. All data collected were de-identified and used for research purposes only.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article. For other data, these may be requested through the corresponding author.

Competing interests

The authors declare that they have no competing interests

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Author's contributions

SKM and SM conceived the study. SKM, BMH, JRK, AK, MS, DCH, and SM contributed to the writing of the manuscript. SM is the principal investigator. SKM is the senior author and guarantor. All authors read, provided feedback, and approved the final manuscript.

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Abbreviations

3TC, Lamivudine; ABC, abacavir; ACC, American college of cardiology; AHA, American heart association; ACE, Angiotensin converting enzyme inhibitors; AOR, adjusted odds ratio; ART, antiretroviral therapy; ASCVD, atherosclerotic cardiovascular disease; AZT, azidothymidine, also called zidovudine; BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; EFV, efavirenz ; FBS, fasting blood sugar; GRZ, government; HDL, high-density lipoprotein; HIV, human immunodeficiency virus; IDF, international diabetes federation; IPAQ, international physical activity questionnaire; IQR, interquartile range; JNC 7, Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; LCH, Livingstone Central Hospital; LDL, low-density lipoprotein; LPV/r,

lopinavir/ritonavir ; MAP, mean arterial pressure; NCD, non-communicable disease; NVP, nevirapine ; OR, odds ratio; PWH, persons with HIV; PP, pulse pressure; SBP, systolic blood pressure; TDF, tenofovir disoproxil fumarate ; WC, waist circumference; WHO STEPS, World health organization stepwise approach to surveillance; WHO, World Health Organizations;

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Table 3

Table 3 was not provided with this version of the manuscript.

Figures

Figure 1

Median age and age category proportions between hypertensive and normotensive participants

Figure 2

Comparison of marital and employment status proportions between hypertensive and normotensive participants

Figure 3

Distribution of body mass index between hypertensive and normotensive participants. Median body mass index (BMI) (panel A) and BMI categories (panel B) compared between hypertensive and normotensive participants

Figure 4

Distribution of waist circumference between hypertensive and normotensive participants. Median waist circumference (WC) (panel A) and WC categories (panel B) compared between hypertensive and normotensive participants

Figure 5

Duration on antiretroviral therapy, fasting blood sugar and diabetes risk scores between hypertensive and normotensive participants

Figure 6

Hypertension distribution by diabetes category

Figure 7

Routine versus standard blood pressure differences. Systolic blood pressure (A, D), diastolic blood pressure (B, E) and pulse (C, E) were significantly different by measurement method. In all cases routine blood pressure and pulse were higher than that measured following standard guidelines. SBP, systolic blood pressure. DBP, diastolic blood pressure.