

ORIGINAL RESEARCH



Exploring the impact of different definitions of blood pressure control prevalence among adults receiving integrated HIV-hypertension services in Lilongwe

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Abstract

Introduction

Large variation exists in how blood pressure (BP) control is reported among people with HIV (PWH) and hypertension in the literature from sub-Saharan Africa.

Methods

At a large HIV clinic in Lilongwe, Malawi, we investigated how reported prevalence of BP control would change depending on the approach used to measure it. In a retrospective study, we compared a hypertension control definition based on cross-sectional (one-visit) BP measurements at the individual's last clinic visit (approach A) with longitudinal observation over one year, where two or three of the most recent BP measurements were used to define control (approach B). Both approaches used the same threshold of $<140/90$ mmHg for control.

Results

Among 167 adults on hypertension treatment and antiretroviral therapy, the mean age was 54 years, 62.3% were female, 60.4% overweight/obese, 98.7% had suppressed viral load ($<1,000$ copies/mL), 9.6% had diabetes and 79.0% were on ≥ 2 antihypertensive drugs. Hypertension control was estimated to be 65.3% using approach A and 55.7% using approach B, a 9.6% difference (95% confidence interval 1.7-17.5%; $p=0.017$).

Conclusion

These findings suggest that use of a single-visit BP overestimates control and indicate that a standardized definition of BP control using longitudinal data will help generalizing results of studies on hypertension control in PWH

Introduction

Uncontrolled hypertension is a large public health concern, especially in low- and middle-income countries. This is because undiagnosed hypertension and poor blood pressure (BP) control among individuals on treatment are common¹. Among people with HIV (PWH), hypertension has a high prevalence and is an increasing cause of morbidity and mortality². Studies from Africa have found that the prevalence of BP control among individuals receiving integrated antiretroviral therapy (ART) and hypertension treatment at ART clinics is generally low, but control rates varied widely, between 24% and 90%³⁻⁶.

There may be several reasons for large differences in hypertension control rates across studies. Studies may have different settings, populations and ART regimens impacting on hypertension and BP control. BP management may improve over time as ART clinicians gain more experience with hypertension management. An alternative hypothesis is that discrepancies in BP control rates are due to the different approaches used to determine BP control prevalence. Some approaches may better adjust for the large, natural, intra-individual variation in BP, whether on hypertension treatment

or not⁷. We therefore conducted a survey at a high-burden HIV clinic in Lilongwe to explore how rates of BP control in a population on integrated HIV-hypertension treatment vary when different definitions are used. Because factors associated with uncontrolled BP are often determined to target BP control interventions to specific groups, a secondary aim of the survey was to explore if associations of covariates with BP control would change using different approaches to determine BP control.

Methods

Malawi is a low-income country with a high prevalence of hypertension and HIV^{8,9}. The Moyo clinic at the Partners in Hope Medical Facility, based in urban Lilongwe, the capital of Malawi, is a PEPFAR-supported center-of-excellence for HIV care and treatment with around 6,000 individuals receiving free-of-charge ART care. The clinic developed fully integrated HIV-hypertension services in 2019 (hypertension screening, diagnosis and management) in a "one-stop" model. Aligned multi-month dispensing of free-of-charge ART and anti-hypertension medication started in 2022.

Table 1. Characteristics of 167 enrolled individuals on integrated HTN-ART management

Variable	n/median	% / IQR
n	167	
Sex		
Female	104	62.3
Male	63	37.7
Media age (years), IQR	54	48-63
28-44 years	31	18.6
45-60 years	77	46.1
61 years or older	59	35.3
Median BMI (kg/m ²), IQR	25.8	21.8-30.9
Underweight	8	4.8
Normal weight	58	34.7
Overweight	49	29.3
Obesity	52	31.1
Median years on ART, IQR	12.5	9.7-15.2
VL results		
Undetectable	152	91
LLV*	13	7.8
Missing	2	1.2
HTN treatment status		
On 1 anti-HTN drug	35	21
On ≥2 anti-HTN drugs	132	79
Diabetes mellitus		
No	151	90.4
Yes	16	9.6

ART, antiretroviral therapy; HTN, hypertension; IQR, inter-quartile range; BMI, body mass index; VL, viral load; LLV, low level viremia
 *any detectable VL <1,000 copies/mL

At routine visits, the BP is determined and reported as follows. BP is measured among adults at every visit, after a rest of at least five minutes. If normal (systolic <140 mm mercury [Hg] and diastolic <90 mm Hg), this BP is recorded; if elevated, the measurement is repeated and the second measurement is recorded.

All ART clients at the Moyo clinic who were registered with hypertension and had at least one BP measurement in the quarter between 1 October 2023 through 31 December 2023, as well as at least two measurements in the year before their clinic visit date, were considered for inclusion by random selection.

In a retrospective observational study with cross-sectional and longitudinal elements, we compared the prevalence of controlled BP using two different approaches. Approach A was based on the BP determined on a single visit, i.e. the last clinic visit in the quarter, and BP control is classified as systolic <140 mm Hg and diastolic <90 mm Hg. Approach B was based on a period of one years' observation during which a minimum of two BP measurements needed to be available. Among participants with 2 measurements, both had to be below systolic <140 mm Hg and diastolic <90 mm Hg for a determination of BP control. Among those with 3 or more BP measurements, 2 of the last 3 measurements had to be below systolic <140 mm Hg and diastolic <90 mm Hg for BP to be classified as controlled¹⁰.

We extracted information about these individuals from routinely used data sources. Hypertension treatment details and BP measurement data were taken from individual

treatment cards. HIV-related information was extracted from the electronic monitoring system. Data were entered with tablets into a SurveyCTO database and analyzed using Stata software (StataCorp LLC, Texas, USA).

We assumed that the prevalence of controlled BP by approach A (known from routine quarterly clinic reports) is 65% and the prevalence by approach B at the same time in 2023 is around 50%. We powered our study ($\beta = 80\%$) to observe a difference of at least 15% in the sample. With an α of 0.05 in a single sample, a sample size of 172 was sufficient to observe this difference. We compared the prevalence of BP control found with approach A versus approach B, using McNemar's test for paired samples. We also evaluated agreement between two approaches with Cohen's Kappa statistic that accounts for agreement by chance, with outcomes interpreted as: 1 perfect agreement; 0 agreement by chance and -1 perfect disagreement. To explore the associations of characteristics with uncontrolled BP, stratified by the two approaches to determine BP control, we used univariable analysis with Chi-squared and Kruskal-Wallis tests.

This study is covered by ethics approval from the National Health Science Research Committee for analyses using retrospective, routinely collected HIV care and treatment data (Protocol Number NHSRC-1099), which waived individual informed consent.

Results

We randomly selected 172 individuals on integrated ART-hypertension treatment for the analysis to compare the two approaches to determine BP control prevalence. Five individuals did not have a minimum of two BP measurements in the last year and were excluded from the analysis. An overview of the characteristics of the study population is provided in table 1. The female sex prevalence of 62.3% reflects the female preponderance in the clinic population. The median age was 54 years, 60.4% were overweight or obese and the median duration on ART was 12.5 years. Apart from two individuals with missing VL results, all others had a suppressed VL (<1,000 copies/mL). Nearly eight in ten were on at least 2 anti-hypertensive drugs and the prevalence of type 2 diabetes mellitus was 9.6%, which is higher than the clinic's estimated overall diabetes prevalence among individuals on ART of 2.7% at the time of this survey.

Five individuals had two BP measurements in the year of observation and the other 162 had three or more. We calculated that the prevalence of BP control was 65.3% (109/167) determined with approach A and 55.7% (93/167) with approach B, a 9.6% difference (95% CI 1.7%-17.5%; p-value 0.017). There was moderate agreement between the two approaches to determine BP control prevalence, Cohen's Kappa = 0.5 (observed agreement 76%).

In the unadjusted analysis of factors associated with BP control (Table 2), being on two or more anti-hypertensive drugs was significantly associated with uncontrolled BP in both approaches to determine BP control prevalence. None of the other characteristics were significantly associated with BP control in either approach.

Discussion

At a high-burden ART clinic in urban Lilongwe, we found a higher prevalence of BP control among individuals on integrated ART-hypertension management, using cross-sectional, one-visit BP measurements compared to using an approach to determine BP control prevalence based on at

Table 2. Factors associated with BP control stratified by two approaches to determine BP control

Variable	Approach A					Approach B				
	Uncontrolled BP		Controlled BP		p-value	Uncontrolled BP		Controlled BP		p-value
	n	% / IQR	n	% / IQR		n	% / IQR	n	% / IQR	
n	58	34.7	109	65.3		74	44.3	93	55.7	
Sex										
Female	41	70.7	63	57.8	0.102	52	70.3	52	55.9	0.057
Male	17	29.3	46	42.2		22	29.7	41	44.1	
Median age (years), IQR	53.5	49.0-61.0	54	47.0-63.0	0.995	52	46.0-62.0	56	49.0-63.0	0.232
28-44 years	10	17.2	21	19.3	0.362	17	23.0	14	15.1	0.183
45-60 years	31	53.5	46	42.2		36	48.6	41	44.1	
61 years or older	17	29.3	42	38.5		21	28.4	38	40.8	
Median BMI (kg/m ²), IQR	26.1	22.4-32.5	25.7	21.5-30.0	0.586	25.8	21.7-30.4	25.8	22.2-31.2	0.945
Underweight	5	8.6	8	7.3	0.638	7	9.5	6	6.5	0.890
Normal weight	18	31.0	40	36.7		26	35.1	32	34.4	
Overweight	15	25.9	33	30.3		21	28.4	27	29.0	
Obesity	20	34.5	28	25.7		20	27.0	28	30.1	
Median years on ART, IQR	12.3	8.7-15.4	12.6	10.4-15.2	0.916	12.5	9.7-15.3	12.5	9.8-15.2	0.931
VL results										
Suppressed	49	84.5	103	94.5	0.070	65	87.8	87	93.5	0.437
LLV*	8	13.8	5	4.6		8	10.8	5	5.4	
Missing	1	1.7	1	0.9		1	1.4	1	1.1	
HTN treatment status										
On 1 anti-HTN drug	4	6.9	31	28.4	0.001	10	13.5	25	26.9	0.026
On ≥2 anti-HTN drugs	54	93.1	78	71.6		64	86.5	68	73.1	
Diabetes mellitus										
No	51	87.9	100	91.7	0.426	64	86.5	87	93.5	0.124
Yes	7	12.1	9	8.3		10	13.5	6	6.5	

BP, blood pressure; IQR, inter-quartile range; SD, standard deviation; BMI, body mass index; VL, viral load, ART, antiretroviral therapy; HTN, hypertension; LLV, low level viremia *any detectable VL <1,000 copies mL

Table 3. Definitions of BP control and BP control outcomes in selected studies of PWH and hypertension from Sub-Saharan Africa

Study (reference)	BP control definition	Study details	Reported BP control outcomes
Kalyesubula R et al. (5)	SBP <140 mm Hg and DBP <90 mm Hg at the second and successive visits	Retrospective study; 1996 PWH 18+ years; 2009-2014; Uganda	BP control rose from 14/53 (26%) in 2009 to 37/105 (35%) in 2013.
Hoffman RM et al. (11)	BP <140 mm Hg systolic and <90 mm Hg diastolic at all visits, or at all but one visit, during one year of follow-up.	Prospective cohort study. Study population PWH 18+ years old, on ART; 2015-2017; Malawi	19% achieved BP control over the year of follow-up.
Jackson LI et al. (6)	SBP <140mmHg and DBP <90mmHg from average of two close BP readings taken 30 seconds apart	Cross-sectional study; study population: 18+ years, PWH, on ART for 3+ months; 2018; Nigeria	24% of hypertensive participants had controlled BP
Steffen HM et al. (3)	BP less than 140/90 mmHg per visit on at least two occasions during the first three visits (month 0, 1, and 3)	Prospective cohort study: study period 2014-2019; study population 18+ years old ART naive. They were followed at month 0, 1, 3, 6 and every 6 months until month 36; Malawi	Controlled treated hypertension was 6/23 PLHIV (26%) at study entry and 17/61 (28%) at month 36.
Ajayi OA et al. (12)	Two consecutive BP measurements of <140 and <90 mmHg on the interview day	Cross-sectional study; 2613 adult PWH (18+ years) who initiated ART between 2004 and 2020; Nigeria	52% had controlled BP
Amutuhair W et al. (4)	Any time during follow up when BP <140 and <90mmHg on a single clinic visit was achieved	Prospective cohort study; 2019-2020; 877 PWH 18+ years, newly diagnosed, treatment-naïve hypertension; follow up until BP control; Uganda	Cumulatively, 90% achieved BP control by the fourth month
Whitehead HS et al. (10)	Individuals were included if they had at least 2 visits with a BP recorded in the prior 12 months. If >3 BP measures were recorded, only the most recent 3 were considered. Uncontrolled hypertension was defined as ≥2 measurements ≥140 and/or ≥90 mmHg	Retrospective cohort study; 2021-2022; 359 adults (18+ years) on ART and antihypertensive medications during the previous year with aligned ART dispensing; Malawi	23% had controlled BP

BP, blood pressure; PWH, people with HIV; SBP, systolic BP; DBP, diastolic BP; ART, antiretroviral therapy

least two measurements in longitudinal follow up.

The impact of variability in BP measurement for diagnosis and treatment monitoring has been well documented, showing that more frequent measurements are more robust to deal with high intra-individual variability, including for BP control when on anti-hypertensives⁷. Therefore, individual clinical decisions for diagnosis and management of hypertension are typically based on longitudinal measurements, which may include clinic and home-based monitoring, given the lack of a reliability of a single measurement. However, limited attention has been given in the literature to the impact of different approaches to determine BP control prevalence in populations of PWH and hypertension. A variety of approaches has been used to determine BP control prevalence in studies from the region (3-6; 10-12), as shown in Table 3.

Of the seven studies referenced, three^{4,6,12} used a method similar to our approach A. In line with our results, two of these three studies had notably higher BP control prevalence than in the studies using longitudinal approaches, underlining that a prevalence based on one-visit measurements overestimates the prevalence of stable BP control. While the other four studies used longitudinal observations of BP measurements at multiple visits, there were relevant variations between these studies in the approaches to determine BP control^{3,5,10,11}.

Malawi's national HIV management guidelines do not indicate how programmatic overviews of BP control need to be specified¹³ and national HIV program reports do not yet include BP control among individuals on ART with hypertension comorbidity (14). We recommend including at least two BP measurements to determine the prevalence of BP control in Malawi's HIV program. This requires longitudinal follow up, which is challenging in programmatic circumstances, but the current, widespread use of electronic monitoring systems would make it feasible.

We did not find a difference in significant associations of participant characteristics with BP control by approach to determine BP control. Since our study was not powered to determine such differences, no conclusions should be drawn from these secondary findings.

Our survey has a number of limitations. It is a single site observation at a large, urban, center-of-excellence clinic. Therefore, the study population, with its median age of over 54 years and on long-term ART with excellent virological suppression, may not be representative of the population on HIV and hypertension treatment in Malawi. At each clinic visit, BP was routinely reported on the basis of one (if below the hypertension threshold) or two measurements (if the initial BP was elevated). This had been decided for practical reasons, to avoid lay cadre staff having to calculate means of ≥ 2 BP results, but it is not the generally recommended method of BP reporting, which is the average of at least 2 measurements¹⁵. Selection bias may have arisen from excluding individuals with less than two BP measurements in the preceding year, as they may have been less engaged in care. However, such exclusion happened only in 5 of 172 (3%) randomly selected participants and therefore would not have had a large impact on the results. We used one out of a variety of longitudinal approaches for determining BP control prevalence to compare with the cross-sectional approach, therefore results may have varied using other longitudinal approaches. We did not have sufficient power to do a multivariable analysis in the comparison of factors

associated with BP control, stratified by approach to determine BP control (a secondary objective of the survey), therefore the results of this analysis are prone to confounding bias.

Our findings, and those from similar studies in the region, underline that the approach to determine BP control prevalence matters for interpretation of outcomes. This is important for comparing different settings, populations and clinic conditions as well as when evaluating interventions to improve BP control. We therefore conclude that standardization of the approach to determine BP control prevalence among PWH in SSA needs attention to further the goals of the research to improve clinical outcomes.

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