ORIGINAL ARTICLE

HIV Comorbidities—Pay Attention to Hypertension Amid Changing Guidelines: An Analysis of Texas Medical Monitoring Project Data

Jessica R. Hyde,[1] Sabeena C. Sears,[2] Justin R. Buendia,[2] Sylvia L. Odem,[2] Margaret L. Vaaler,[2] and Osaro O. Mgbere[3]

BACKGROUND
Hypertension is a significant risk factor for cardiovascular disease, a leading cause of death among people living with HIV (PLWH). Studies suggest that hypertension prevalence among PLWH is high, yet none assess how the 2017 redefinition of hypertension as ≥130/80 rather than the previous standard of ≥140/90 mm Hg will affect prevalence among PLWH. This study addresses this gap.

METHODS
We examined medical record abstractions of 957 PLWH in Texas from the 2013–2014 Medical Monitoring Project survey. Participants with hypertension were identified by charted diagnosis, antihypertensive medication use, or blood pressure readings ≥140/90 and ≥130/80 mm Hg. Associations with sociodemographic and clinical variables were assessed using Rao–Scott chi-square tests, and odds of having hypertension were calculated using multivariable logistic regression models while adjusting for several demographic and HIV-related variables.

RESULTS
The 2017 redefinition of hypertension increased prevalence in the sample by 44.3%, from 47.6% to 68.7%. Age group, body mass index, sex, and race remained significantly associated with hypertension (all $P < 0.01$). Although prevalence was near equal between males and females at ≥140/90 mm Hg (47.4% and 48.5%, respectively), males were 2.36 times more likely to have hypertension than females (95% confidence interval [CI]: 1.55–3.60) at ≥130/80 mm Hg. Prevalence remained comparable between white (73.3%) and black participants (72.9%).

CONCLUSIONS
This study shows that hypertension prevalence is remarkably high among PLWH and is further increased by updated guidelines. Barriers to hypertension control in the HIV care setting should be identified and addressed to facilitate continued improvement in the quality and length of life for PLWH.

Keywords: blood pressure; guidelines; high blood pressure; HIV; hypertension.

doi:10.1093/ajh/hpz078

Before the treatment for HIV became widely available in the United States in the mid-1990s, people living with HIV (PLWH) typically died within 12 years of infection.[1] Nearly 90% of deaths among PLWH between 1987 and 1989 were attributable to AIDS-defining opportunistic infections or malignancies.[2] After more than 30 years of advancement in treatment regimens, availability of testing, and access to care, HIV is no longer a death sentence. Although PLWH who achieve viral suppression can now survive decades after infection, they live with increased risk and burden of chronic disease.[3] In high-income countries, the majority (53%) of deaths in PLWH are unrelated to HIV, 15% of which result from cardiovascular disease.[4] Hypertension is a chief risk factor for cardiovascular disease and is implicated in 75% of all heart attacks and strokes.[5,6] Hypertension also has a steep economic impact. The average annual cost of hypertension in the United States exceeded $51 billion from 2012 to 2013.[7] Approximately 1 in 3 US adults have been diagnosed with hypertension.[8] Hypertension tends to be a common comorbidity among PLWH as well, with reported prevalence ranging from 4% to 57%.[9]

The diagnostic criteria for hypertension were updated for the first time in 14 years in the *2017 Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults*, a report developed by the American College of Cardiology (ACC) and the American Heart Association (AHA) Task Force on Clinical Practice Guidelines (ACC/AHA 2017). The guidelines redefine

Correspondence: Jessica Hyde (JessicaR.Hyde@dshs.texas.gov).
Initially submitted February 14, 2019; date of first revision April 26, 2019; accepted for publication May 7, 2019; online publication May 9, 2019.

[1]Health Promotion and Chronic Disease Prevention Section, Community Health Improvement Division, Texas Department of State Health Services, Austin, Texas, USA; [2]TB/HIV/STD Section, Laboratory and Infectious Disease Services Division, Texas Department of State Health Services, Austin, Texas, USA; [3]Disease Prevention and Control Division, Houston Health Department, Houston, Texas, USA.

hypertension as systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥80 mm Hg.[10] These more aggressive targets facilitate earlier identification and the treatment of hypertension before damage to the cardiovascular system begins,[10] as risk of death from cardiovascular events doubles for every 20 mm Hg systolic or 10 mm Hg diastolic increase above normal blood pressure (BP).[11] Given the recency of these updates, literature on their potential impact on hypertension prevalence is limited for the general population and even more so for PLWH. To address this dearth in public health research literature, this study investigated the prevalence of hypertension among PLWH receiving medical care in Texas, using thresholds from both the ACC/AHA 2017 (130/80 mm Hg) and the previous standard of 140/90 mm Hg set by the Joint National Commission in 2003 (JNC-7).[12]

METHODS

Medical record abstraction and interview data from the 2013–2014 Medical Monitoring Project (MMP) survey were examined. MMP is an annual supplemental surveillance system funded by the Centers for Disease Control and Prevention that monitors behavioral and clinical characteristics of adult PLWH receiving medical care across 23 project areas nationwide, which includes the city of Houston and the rest of Texas. Houston was selected as an MMP site due to its high HIV morbidity; likewise, Texas was selected for its high HIV morbidity excluding Houston.

MMP is a cross-sectional survey that uses a 3-stage, probability proportional to size sampling methodology: (i) the first stage of sampling is at a geographic level for the United States and dependent areas; (ii) the second stage is at a facility level through selection of outpatient small, medium, and large HIV care facilities; and (iii) finally, the third stage is on an individual level. Sampled participants must have been 18 years of age or older and have had at least one medical care visit at a sampled facility between January and April of 2013 and 2014 to be included. A total of 1,600 PLWH were sampled for the 2013–2014 Texas and Houston MMP surveys. Data collection took place between June 2013 and May 2015 via a telephone or in-person patient interview and a medical chart review. In Texas and Houston, facility response rates ranged from 78.8% to 82.7%; patient response rates ranged from 60.4% to 61.3%. A total of 957 participants were interviewed between the Texas and Houston MMP surveys, and these participants were recruited from 43 participating outpatient HIV care facilities. The data obtained were weighted to account for the probabilities of selection at each sampling stage. Nonresponse adjustments accounted for differing responses at both facility and patient levels and multiplicity adjustments accounted for patients' visits to more than one HIV care facility.[13]

Measures

Participants with hypertension were identified by documented diagnosis, record of antihypertensive medication, or high BP readings within the preceding 2 years. To analyze BP readings, we used both JNC-7 and ACC/AHA 2017 diagnostic criteria to assess the impact of changing guidelines. We used both cut points in an algorithm developed by Rakotz et al.[14] to identify patients at risk of hypertension using electronic health records in a primary care setting. Table 1 describes the algorithm in greater detail.

Table 1. Diagnostic criteria used to identify hypertensive participants.[10,12,14]

Measure	JNC-7 (mm Hg)	ACC/AHA 2017
Average of last 3 systolic readings	≥140	≥130
Average of last 3 diastolic readings	≥90	≥80
One systolic reading	>180	>180
One diastolic reading	>120	>120
Three systolic readings	≥140	≥130
Three diastolic readings	≥90	≥80

Note: Only one criterion needed to be met to be classified as hypertensive for analysis.

Abbreviations: ACC/AHA 2017, American College of Cardiology and American Heart Association's 2017 *Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults*; JNC-7, *Guidelines from The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*.

All participants who were on antihypertensive medications had a diagnosis of hypertension in their medical chart. Similar diagnoses, such as elevated BP, were included. We only classified participants as nonhypertensive if the average of their last 3 BP readings were normal using JNC-7 and ACC/AHA 2017 criteria for each respective analysis. If there was not a diagnosis of hypertension or antihypertensive medications recorded in the medical chart, we could not assume that these participants did not have hypertension. Participants could have sought non-HIV care and/or prescriptions for non-HIV medications at other medical facilities from which medical record abstractions are not available. Respondents who did not have either diagnosis or medication information or at least 3 BP readings were excluded from the analysis ($n = 46$), leaving a final analytic sample of 911 participants.

Sociodemographic characteristics examined in the study include age group, sex at birth, race/ethnicity, education, health insurance type, current smoking status, alcohol use, and poverty level. Length of time on antiretroviral therapy (ART) was determined from patient self-report. Clinical variables included time since HIV diagnosis, duration of ART use, viral suppression status, and body mass index (BMI) calculations using the most recent height and weight.

Statistical analysis

Weighted prevalence and 95% confidence intervals (CIs) of hypertension among PLWH were calculated as an overall measure and by each of the following categories of sociodemographic and HIV-related characteristics: age group (18–39, 40–49, and ≥50 years), sex at birth (male or female), race/ethnicity (white, black, and Hispanic), education (<high school diploma, high school diploma or general equivalency diploma, and >high school diploma), poverty level (at or below federal poverty line and above), insurance

(none, public inclusive of Ryan White, and private), binge drinking, BMI (under- and normal weight (≤24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2)), smoking (current, former, and never), time since HIV diagnosis (<5, 5–9, and ≥10 years), viral load (<200 vs. ≥200 copies/mL), and length of time on ART (<5, 5–9, and ≥10 years). Multivariable logistic regression models were used to identify factors associated with hypertension and to compute adjusted odds ratios and corresponding 95% CIs among PLWH. All aforementioned sociodemographic and clinical variables were used as independent predictors. We conducted univariable analysis of these sociodemographic and clinical variables to determine their independent associations with hypertension based on the 2 guidelines. Following the outcomes, the predictor variables were selected *a priori*, if they were statistically significant at $P < 0.10$ or if they were epidemiologically important (e.g., sex at birth[15] and binge drinking[16]) and included in the final multivariable logistic regression models by guideline. This process allowed for simultaneous adjustments of any potential confounders and produced estimates of *P* values, adjusted odds ratios and 95% CIs for each model. All tests performed were 2-tailed, with a probability value of 0.05 used as the statistical significance level. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC) and accounted for clustering, unequal selection probabilities, and nonresponse.

RESULTS

Table 2 compares weighted hypertension prevalence between JNC-7 and ACC/AHA 2017 guidelines by sociodemographic and clinical variables. Hypertension prevalence as defined by JNC-7 was markedly higher among sampled PLWH (47.6%) than the general adult population in Texas in 2013 (31.2%; Table 3).[17] Age group, race and ethnicity, BMI, smoking status, binge drinking, duration of ART use, and time since HIV diagnosis were significantly associated with hypertension (all $P < 0.01$); however, age may confound some of these relationships. Although 18–39-year-olds had the lowest hypertension prevalence of all the age groups at 24.9%, it should be noted that this is still 2.3 times greater than the prevalence seen among their counterparts in the general population of Texas in 2013 (Table 3).[17] Hypertension prevalence by sex at birth was near equal at 47.4% for males and 48.5% for females. Prevalence was also comparable between white (50.2%) and black participants (53.4%). Prevalence was considerably lower for Hispanic participants at 38.6%. Participants who were 50 years of age or older, obese, former smokers, on ART ≥10 years, or had undetectable viral loads (<200 copies/mL) had hypertension prevalences of 67.7%, 62.9%, 58.3%, 61.1%, and 45.1%, respectively.

On lowering the hypertension threshold to 130/80 mm Hg as recommended in ACC/AHA 2017, prevalence increased to 68.7% among the sample. Age group, race and ethnicity, BMI, smoking status, duration of ART use, and time since HIV diagnosis remained significantly associated with hypertension (all *P*s < 0.01); however, the relationship between binge drinking and hypertension lost significance ($P = 0.38$). The gap in prevalence by sex at birth widened, with 70.2% of males and 64.0% of females considered to have hypertension. Prevalence remained comparable between white (73.3%) and black participants (72.9%). The majority of obese participants (84.4%), those ≥50 years of age (83.0%), former smokers (79.4%), on ART for ≥10 years (79.6%), and undetectable viral loads (69.7%) were considered to have hypertension.

Table 4 compares adjusted odds ratios between guidelines by sociodemographic and clinical variables. Age group and BMI were statistically significant predictors of hypertension under both guidelines. Under both guidelines, younger age (<50 years) was a statistically significant protective factor against hypertension, with 60–80% lower odds of hypertension. Compared to under- and normal weight participants, those who were obese were 3.03 (95% CI: 2.00–4.58) and 6.00 (95% CI: 3.55–10.13) times more likely to be hypertensive under JNC-7 and ACC/AHA 2017, respectively. African American race was a significant predictor under JNC-7 but retained only marginal significance under ACC/AHA 2017. Black participants were 1.73 (95% CI: 1.16–2.58) and 1.51 (95% CI: 0.98–2.35) times more likely to have hypertension than whites in the JNC-7 and ACC/AHA 2017 analyses, respectively. Sex at birth was a significant predictor in both guidelines. Males were 1.55 (JNC-7; 95% CI: 1.04–2.31) and 2.36 (ACC/AHA 2017; 95% CI: 1.55–3.60) times more likely to have hypertension than females. HIV-related clinical variables, such as duration of ART use and time since HIV diagnosis, were not significantly associated with hypertension odds.

DISCUSSION

The ACC and AHA anticipate the updated guidelines will increase the national prevalence of hypertension by 42.9%, from 31.9% to 45.6%.[18] Similarly, hypertension prevalence in our sample increased by 44.3%, from 47.6% to 68.7%, when using the ACC/AHA 2017 diagnostic criteria. Our JNC-7 results corroborate those of other multi-site analyses of PLWH from Washington, DC,[19] St. Louis, and Philadelphia,[20] as well as analyses of 2007 Veteran's Affairs case registries[21] and national 2013–2014 MMP data.[22] All paint a picture of disproportionate burden of hypertension among PLWH, which is further increased by the more aggressive diagnostic thresholds set in the ACC/AHA 2017 guideline. This is most likely the result of a combination of conventional cardiovascular disease risk factors and HIV-related factors, including but not limited to aging, cigarette smoking, overweight or obesity, and HIV- or ART-mediated effects.

Incidence of hypertension in PLWH increases by approximately 34% for every 10-year increase in age, with the highest risk among those 40 years of age or older who have lived 10 or more years with HIV.[23,24] Age group was a significant predictor of hypertension ($P < 0.01$) in the analysis of both guidelines. Nearly 60% of PLWH in care in Texas are more than the age of 45, and more than half have lived 10 or more years since their HIV diagnosis, which may be a substantial driver of hypertensive prevalence in our sample. African American heritage is another nonmodifiable risk factor for hypertension in the general population.[25] Surprisingly, there was a negligible difference in hypertension prevalence between whites and blacks in our sample; however, black participants were still 1.73 and 1.51 times more likely to have

Table 2. Weighted prevalence of hypertension by sample baseline characteristics and diagnostic guidelines

Baseline characteristic	*n*	JNC-7 (%)	*P*	ACC/AHA 2017 (%)	*P*
Age group (years)[a]					
18–39	266	24.9	<0.01	50.2	<0.01
40–49	278	43.4		67.8	
≥50	367	67.7		83.0	
Sex at birth					
Male	665	47.4	0.79	70.2	0.09
Female	246	48.5		64.0	
Race/ethnicity[a]					
White	210	50.2	<0.01	73.3	<0.01
Black	390	53.4		72.9	
Hispanic	284	38.6		60.2	
BMI (kg/m^2)[a]					
≤24.9	329	40.8	<0.01	55.9	<0.01
25.0–29.9	332	43.6		70.5	
≥30.0	248	62.9		84.4	
Education					
<HS diploma	172	49.7	0.62	66.9	0.80
=HS diploma/GED	255	45.1		68.1	
>HS diploma	483	48.4		69.7	
Insurance					
Uninsured	28	34.2	0.26	51.2	0.25
Public[b]	643	49.3		69.0	
Private	230	44.5		69.1	
Poverty					
Above FPL	441	46.4	0.29	69.3	0.66
Below FPL	445	50.0		67.9	
Smoking status[a]					
Never smoker	415	42.8	<0.01	66.2	<0.01
Former smoker	197	58.3		79.4	
Current smoker	296	47.3		65.3	
Binge drinking					
Yes	151	40.8	0.047	65.4	0.38
No	755	49.4		69.4	
Duration of ART use[a] (years)					
<10	468	37.0	<0.01	60.4	<0.01
≥10	375	61.1		79.6	
Time since HIV diagnosis[a] (years)					
<5	227	35.4	<0.01	61.1	<0.01
5–9	212	37.2		58.7	
≥10	472	58.9		77.2	
Viral load (copies/mL)					
<200	647	48.7	0.36	69.7	0.34
≥200	264	45.1		66.2	
Total	911	47.6		68.7	

Abbreviations: ACC/AHA 2017, American College of Cardiology and American Heart Association's *2017 Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults*; ART, antiretroviral therapy; BMI, body mass index; FPL, federal poverty level; GED, general equivalency diploma; HS, high school; JNC-7, Guidelines from *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure.*

[a]Statistically significant under both guidelines at $P < 0.05$.

[b]Includes Ryan White assistance.

Table 3. Comparison of weighted hypertension prevalence among sample and the Texas population by demographics and guidelines[12]

Baseline characteristic	2013 Texas BRFSS[a] (%)	2013–2014 MMP JNC-7 (%)	2013–2014 MMP ACC/AHA 2017 (%)
Age group (years)			
18–39	10.8	24.9	50.2
40–49	25.9	43.4	67.8
50+	54.4	67.7	83.0
Sex			
Male	32.2	47.4	70.2
Female	30.2	48.5	64.0
Race/ethnicity			
White	33.3	50.2	73.3
Black	42.6	53.4	72.9
Hispanic	25.3	38.6	60.2
Total	31.2	47.6	68.7

Abbreviations: BRFSS: Behavioral Risk Factory Surveillance System; JNC-7: Guidelines from *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*; MMP: Medical Monitoring.

[a]Weighted responses to Question 5.1: "Have you ever been told by a doctor, nurse, or other health professional that you have high blood pressure?" JNC-7 guidelines were the standard at the time of the 2013 Texas BRFSS survey; however, diagnostic criteria used are at the discretion of the respondents' health care provider.

hypertension than whites in the JNC-7 and ACC/AHA 2017 analyses, respectively.

Modifiable risk factors also likely influence the prevalence of hypertension among PLWH, such as smoking.[25] One-third of our sample were current smokers, compared to 15.9% of Texas adults in 2013.[17] Another 21.6% of the sample were former smokers, who had the highest prevalence of hypertension of any smoking status in both analyses. Although cigarette smoking immediately—but only temporarily—raises BP due to the vasoconstrictive properties of nicotine,[26] the association with hypertension may be due to increased risk of long-term, cumulative damage to the blood vessels or atherosclerosis.[26,27]

Former smokers also tend to be at greater risk of obesity than current smokers and those who have never smoked.[28] Wasting, once a defining characteristic of advanced HIV infection, is now more an exception than the rule.[29] Only 6.1% of our sample were underweight, as defined by BMI, whereas 63.9% were overweight or obese. This is comparable to the prevalence of overweight or obesity seen in the Texas general population during the same observational period at 66.1%.[17] This may result from the combination of improved HIV control and the growing obesity epidemic in the United States; however, it may also be a side effect of HIV medications.[29] Certain classes of ART may be associated with weight gain,[29,30] as well as peripheral lipoatrophy and visceral lipohypertrophy,[9] both of which are independently associated with hypertension.[31] Obesity increases the risk of hypertension and other cardiovascular conditions,[25] and increased central adiposity is positively correlated with hypertension, especially in young men.[32]

Emerging research indicates that inflammatory immune response to HIV infection may damage the endothelial receptors in the lining of the vasculature[33] or cause arterial stiffness,[31] leaving PLWH predisposed to developing hypertension. Although there are conflicting studies on the relationship between hypertension and the class and/or duration of ART, our results demonstrate a significant association between length of time on any ART and hypertension. ART-mediated effects should be interpreted with caution, however, as age could confound the results. Also, their impact may be more directly related to physiological sequelae of immune suppression and reconstitution rather than the medications themselves.[31]

To monitor the effectiveness of treatment, PLWH retained in care typically have at least 2–3 clinical encounters each year.[34,35] These are prime opportunities to concurrently address hypertension and other chronic disease risk factors to improve the quality and length of life. These encounters may also provide younger PLWH with the chance to identify risk factors and prevent or manage hypertension earlier than their counterparts in the general population who may not interact with the health care system as frequently.[36] But how often is hypertension discussed during routine HIV care? Although literature is limited on awareness of hypertension status among PLWH, available international reports point toward low awareness[9,37] and low health care provider engagement on the topic.[31,38]

Suppressed HIV infection blurs the lines between infectious and chronic disease, which necessitates further research to identify both provider- and patient-related barriers to successful prevention, identification, treatment, and management of hypertension within the HIV care setting. Once barriers are known, infectious disease and primary care specialties can work together with public health professionals to break down clinical inertia and assess which clinical interventions will work best in the HIV care setting. Potential interventions include team-based care, self-management education and support, and self-measured BP monitoring, 3 multidisciplinary best practices for cardiovascular disease prevention and management.[39,40]

Although the MMP is a rigorous public health surveillance tool, the 2013–2014 MMP survey only represents PLWH receiving medical care; therefore, results may not be generalizable to those who are not linked to care or are unaware of their HIV status. In 2015, Centers for Disease Control and Prevention modified MMP sampling methods to include PLWH who are not engaged in HIV care to capture a more representative sample. Those data may enable us to better enumerate actual prevalence of hypertension among PLWH in Texas in future analyses. Analysis of BP control rates among PLWH is another point of future research interest, as it will inform clinical practice recommendations specific to this subpopulation.

In summary, hypertension is a highly prevalent comorbidity for PLWH. The 2017 redefinition of hypertension increased prevalence in the sample by 44.3%, from 47.6% to 68.7%. Because PLWH in care are living longer after HIV infection, chronic diseases and their risk factors should be routinely addressed and normalized in HIV care, including

Table 4. Adjusted odds ratios of hypertension by sample baseline characteristics and diagnostic guidelines

	Adjusted odds ratio	
Baseline characteristic[a]	**JNC-7**	**ACC/AHA**
Age group (years)		
18–39[b]	0.20 (0.12–0.34)	0.20 (0.13–0.33)
40–49[b]	0.36 (0.24–0.54)	0.40 (0.26–0.60)
≥50	1.00 (reference)	1.00 (reference)
Sex at birth		
Male[b]	1.55 (1.04–2.31)	2.36 (1.55–3.60)
Female	1.00 (reference)	1.00 (reference)
Race/ethnicity		
White	1.00 (reference)	1.00 (reference)
Black	1.73 (1.16–2.58)	1.51 (0.98–2.35)
Hispanic	0.91 (0.61–1.35)	0.72 (0.45–1.16)
BMI (kg/m^2)		
≤24.9	1.00 (reference)	1.00 (reference)
25.0–29.9	1.18 (0.77–1.82)	1.88 (1.23–2.87)
≥30.0[b]	3.03 (2.00–4.58)	6.00 (3.55–10.13)
Smoking status		
Never smoker	1.00 (reference)	1.00 (reference)
Former smoker	1.40 (0.91–2.17)	1.63 (0.97–2.74)
Current smoker	1.34 (0.92–1.95)	1.08 (0.67–1.73)
Binge drinking		
Yes	0.85 (0.58–1.27)	0.98 (0.63–1.53)
No	1.00 (reference)	1.00 (reference)
Duration of ART use		
<10	1.00 (reference)	1.00 (reference)
≥10	1.39 (0.69–2.77)	1.56 (0.71–3.44)
Time since HIV diagnosis (years)		
<5	0.90 (0.46–1.78)	1.32 (0.59–2.95)
5–9	0.77 (0.38–1.54)	0.87 (0.43–1.76)
≥10	1.00 (reference)	1.00 (reference)

Abbreviations: ACC/AHA, Guidelines from the American College of Cardiology and American Heart Association's *2017 Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults*; ART, antiretroviral therapy; BMI, body mass index; JNC-7: Guidelines from *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*.

[a]Only variables that met the entry criteria of $P < 0.10$ in the univariable analysis (Table 2) were included in the final multivariable logistic regression models.

[b]Statistically significant under both guidelines.

hypertension. This will facilitate continued improvement in quality and length of life for PLWH. Further research is needed to identify both provider- and patient-related barriers to successful prevention, identification, treatment, and management of hypertension within the HIV care setting.

HUMAN SUBJECTS

MMP has been determined by the National Center for HIV, Viral Hepatitis, STD and TB Prevention's Office of the Associate Director for Science at the Centers for Disease Control and Prevention to be a nonresearch public health surveillance activity used for disease control program or policy purposes. As such, MMP is not subject to human subjects' regulations, including federal institutional review board approval. All data collection was Health Insurance Portability and Accountability Act compliant. Informed consent was obtained from all individual participants included in the study.

ACKNOWLEDGMENTS

The authors would like to thank the HIV care facilities and sampled persons who participated in the Medical Monitoring Project (MMP) from the Texas and Houston project areas. We would also like to acknowledge the MMP staff from the participating project areas for the data collection, including the Houston Health Department; management and members of the Community Advisory Board and Provider Advisory Board at the Texas Department of State Health Services; and members of the Clinical Outcomes Team in Centers for Disease Control and Prevention's Behavioral and Clinical Surveillance Branch of the Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention for their respective support and contributions. The Medical Monitoring Project data collection cycles used in the current study were supported by the CDC under cooperative agreement number PS09-937.

DISCLOSURE

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

DISCLAIMER

The findings and conclusions of this article are solely the responsibility of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, the Texas Department of State Health Services, or the Houston Health Department.

REFERENCES

1. Peiperl L. [Internet]. FAQ: How Long Can People Infected With HIV Expect to Live?—HIV/AIDS. 2005 [cited 2017Dec4]. Available from: www.hiv.va.gov/patient/faqs/life-expectancy-with-HIV.asp
2. Chu SY, Buehler JW, Lieb L, Beckett G, Conti L, Costa S, Dahan B, Danila R, Fordyce EJ, Hirozawa A. Causes of death among persons reported with AIDS. *Am J Public Health* 1993; 83:1429–1432.

3. Samji H, Cescon A, Hogg RS, Modur SP, Althoff KN, Buchacz K, Burchell AN, Cohen M, Gebo KA, Gill MJ, Justice A, Kirk G, Klein MB, Korthuis PT, Martin J, Napravnik S, Rourke SB, Sterling TR, Silverberg MJ, Deeks S, Jacobson LP, Bosch RJ, Kitahata MM, Goedert JJ, Moore R, Gange SJ; North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) of IeDEA. Closing the gap: increases in life expectancy among treated HIV-positive individuals in the United States and Canada. *PLoS One* 2013; 8:e81355.
4. Farahani M, Mulinder H, Farahani A, Marlink R. Prevalence and distribution of non-AIDS causes of death among HIV-infected individuals receiving antiretroviral therapy: a systematic review and meta-analysis. *Int. J. STD AIDS* 2017; 28:636–650.
5. Centers for Disease Control and Prevention. Conditions That Increase Risk for Heart Disease [Internet]. 2017 [cited 2017Dec4]. Available from: ww.cdc.gov/heartdisease/conditions.htm
6. Spark A, Dinour LM, Obenchain J. *Nutrition in Public Health: Principles, Policies, and Practice*. Boca Raton: CRC Press/Taylor & Francis Group, 2016.
7. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das SR, Deo R, de Ferranti SD, Floyd J, Fornage M, Gillespie C, Isasi CR, Jiménez MC, Jordan LC, Judd SE, Lackland D, Lichtman JH, Lisabeth L, Liu S, Longenecker CT, Mackey RH, Matsushita K, Mozaffarian D, Mussolino ME, Nasir K, Neumar RW, Palaniappan L, Pandey DK, Thiagarajan RR, Reeves MJ, Ritchey M, Rodriguez CJ, Roth GA, Rosamond WD, Sasson C, Towfighi A, Tsao CW, Turner MB, Virani SS, Voeks JH, Willey JZ, Wilkins JT, Wu JH, Alger HM, Wong SS, Muntner P; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics-2017 update: a report from the American Heart Association. *Circulation* 2017; 135:e146–e603.
8. Centers for Disease Control and Prevention. High Blood Pressure (Hypertension) Information [Internet]. 2018 [cited 2018Nov2]. Available from: www.cdc.gov/bloodpressure/index.htm
9. van Zoest RA, van den Born BH, Reiss P. Hypertension in people living with HIV. *Curr Opin HIV AIDS* 2017; 12:513–522.
10. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD, Wright JT Jr. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2018; 71:e127–e248.
11. National High Blood Pressure Education Program. Blood Pressure and Cardiovascular Risk [Internet]. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. U.S. National Library of Medicine, 2004 [cited 2018Jan16]. Available from: www.ncbi.nlm.nih.gov/books/NBK9634/
12. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ; National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; National High Blood Pressure Education Program Coordinating Committee. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. *JAMA* 2003; 289:2560–2572.
13. Iachan R, Johnson CH, Harding RL, Kyle T, Saavedra P, Frazier EL, Beer L, Mattson CL, Skarbinski J. Design and weighting methods for a nationally representative sample of HIV-infected adults receiving medical care in the United States-medical monitoring project. *Open AIDS J* 2016; 10:164–181.
14. Rakotz MK, Ewigman BG, Sarav M, Ross RE, Robicsek A, Konchak CW, Gavagan TF, Baker DW, Hyman DJ, Anderson KP, Masi CM. A technology-based quality innovation to identify undiagnosed hypertension among active primary care patients. *Ann Fam Med* 2014; 12:352–358.
15. Sandberg K, Ji H. Sex differences in primary hypertension. *Biol Sex Differ* 2012; 3:7.
16. Husain K, Ansari RA, Ferder L. Alcohol-induced hypertension: mechanism and prevention. *World J Cardiol* 2014; 6:245–252.
17. Center for Health Statistics. *Texas Behavioral Risk Factor Surveillance System Survey Data*. Austin, Texas: Texas Department of State Health Services, 2013.
18. Muntner P, Carey RM, Gidding S, Jones DW, Taler SJ, Wright JT Jr, Whelton PK. Potential US population impact of the 2017 ACC/AHA high blood pressure guideline. *Circulation* 2018; 137:109–118.
19. Levy ME, Greenberg AE, Hart R, Powers Happ L, Hadigan C, Castel A; DC Cohort Executive Committee. High burden of metabolic comorbidities in a citywide cohort of HIV outpatients: evolving health care needs of people aging with HIV in Washington, DC. *HIV Med* 2017; 18:724–735.
20. Onen NF, Overton ET, Seyfried W, Stumm ER, Snell M, Mondy K, Tebas P. Aging and HIV infection: a comparison between older HIV-infected persons and the general population. *HIV Clin Trials* 2010; 11:100–109.
21. U.S. Department of Veterans Affairs. Primary care of veterans with HIV [Internet]. Hypertension and HIV—HIV/AIDS. 2009 [cited 2018Mar6]. Available from: www.hiv.va.gov/provider/manual-primary-care/hypertension.asp
22. Olaiya O, Weiser J, Zhou W, Patel P, Bradley H. Hypertension among persons living with HIV in medical care in the United States—medical monitoring project, 2013–2014. *Open Forum Infectious Diseases* 2018; 5(3):ofy028.
23. Okeke NL, Davy T, Eron JJ, Napravnik S. Hypertension among HIV-infected patients in clinical care, 1996-2013. *Clin Infect Dis* 2016; 63:242–248.
24. Medina-Torne S, Ganesan A, Barahona I, Crum-Cianflone NF. Hypertension is common among HIV-infected persons, but not associated with HAART. *J Int Assoc Physicians AIDS Care (Chic)* 2012; 11:20–25.
25. American Heart Association. Know Your Risk Factors for High Blood Pressure [Internet]. 2017 [cited 2018Sep7]. Available from: www.heart.org/en/health-topics/high-blood-pressure/why-high-blood-pressure-is-a-silent-killer/know-your-risk-factors-for-high-blood-pressure
26. American Heart Association. Smoking, High Blood Pressure and Your Health [Internet]. 2016 [cited 2018Sep7]. Available from: www.heart.org/HEARTORG/Conditions/HighBloodPressure/PreventionTreatmentofHighBloodPressure/Tobacco-and-Blood-Pressure_UCM_301886_Article.jsp
27. Virdis A, Giannarelli C, Neves MF, Taddei S, Ghiadoni L. Cigarette smoking and hypertension. *Curr Pharm Des* 2010; 16:2518–2525.
28. Dare S, Mackay DF, Pell JP. Relationship between smoking and obesity: a cross-sectional study of 499,504 middle-aged adults in the UK general population. *PLoS One* 2015; 10:e0123579.
29. Crum-Cianflone N, Roediger MP, Eberly L, Headd M, Marconi V, Ganesan A, Weintrob A, Barthel RV, Fraser S, Agan BK; Infectious Disease Clinical Research Program HIV Working Group. Increasing rates of obesity among HIV-infected persons during the HIV epidemic. *PLoS One* 2010; 5:e10106.
30. Taramasso L, Ricci E, Menzaghi B, Orofino G, Passerini S, Madeddu G, Martinelli CV, De Socio GV, Squillace N, Rusconi S, Bonfanti P. Weight gain: a possible side effect of all antiretrovirals. *Open Forum Infectious Diseases* 2017; 4(4):ofx239.
31. Fahme SA, Bloomfield GS, Peck R. Hypertension in HIV-infected adults: novel pathophysiologic mechanisms. *Hypertension* 2018; 72:44–55.
32. Takeoka A, Tayama J, Yamasaki H, Kobayashi M, Ogawa S, Saigo T, Kawano H, Abiru N, Hayashida M, Maeda T, Shirabe S. Intra-abdominal fat accumulation is a hypertension risk factor in young adulthood: a cross-sectional study. *Medicine (Baltimore)* 2016; 95:e5361.
33. Nduka CU, Stranges S, Sarki AM, Kimani PK, Uthman OA. Evidence of increased blood pressure and hypertension risk among people living with HIV on antiretroviral therapy: a systematic review with meta-analysis. *J Hum Hypertens* 2016; 30:355–362.
34. Roscoe C, Hachey DM. Topic 8. Retention in HIV care [Internet]. National HIV Curriculum. University of Washington, 2017 [cited 2018Oct8]. Available from: www.hiv.uw.edu/go/basic-primary-care/retention-care/core-concept/all
35. Dang BN, Westbrook RA, Hartman CM, Giordano TP. Retaining HIV patients in care: the role of initial patient care experiences. *AIDS Behav* 2016; 20:2477–2487.

36. Longenecker CT. Vascular disease and aging in HIV: time to extend the treatment cascade. *Vasc Med* 2018; 23:476–477.
37. De Socio GV, Ricci E, Maggi P, Parruti G, Celesia BM, Orofino G, Madeddu G, Martinelli C, Menzaghi B, Taramasso L, Bonfanti P, Pucci G, Schillaci G; CISAI study group. Time trend in hypertension prevalence, awareness, treatment, and control in a contemporary cohort of HIV-infected patients: the HIV and Hypertension Study. *J Hypertens* 2017; 35:409–416.
38. 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; 13:342–345.
39. Centers for Disease Control and Prevention. Best Practices for Cardiovascular Disease Prevention Programs: A Guide to Effective Health Care System Interventions and Community Programs Linked to Clinical Services [Internet]. 2017 [cited 2017Oct22]. Available from: www.cdc.gov/dhdsp/pubs/docs/Best-Practices-Guide-508.pdf
40. Balt CA. Hypertension and HIV infection. *J Assoc Nurses AIDS Care* 2013; 24:S127–S134.