

**Title: Hypertension among persons living with HIV in medical care in the United States–  
Medical Monitoring Project, 2013-2014**

**Short title:** Hypertension in persons living with HIV

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## **Abstract**

Hypertension is a leading modifiable risk factor for cardiovascular disease (CVD) and persons living with HIV are at increased risk for both hypertension and CVD. Therefore, using data from a nationally representative sample of patients living with HIV, we assessed missed opportunities for the optimal management of hypertension.

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## Introduction

Cardiovascular disease (CVD) is a leading cause of morbidity and mortality among people living with HIV (PLWH) (1, 2), and hypertension is a primary modifiable risk factor for CVD. Some studies suggest that the prevalence of hypertension among PLWH is higher than among the general population, possibly explained by a higher prevalence of smoking and HIV-specific factors such as immune activation, inflammation, and long-term effects of antiretroviral therapy (3-5). It is important to optimize hypertension screening and management in this at-risk group in order to decrease complications including CVD. We estimated prevalence of hypertension overall, as well as by diagnosis, treatment and control status in a nationally representative sample of patients receiving HIV medical care in the United States.

## Methods

The Medical Monitoring Project (MMP) is a surveillance system designed to produce nationally representative estimates of the behavioral and clinical characteristics of HIV-infected adults in the United States. For the 2013 and 2014 data collection cycles, U.S. states and territories were sampled, followed by outpatient facilities providing HIV care within those jurisdictions, and finally by HIV-infected adults aged 18 years and older who had at least 1 medical care visit in a participating facility during January–April of the referent year.

Data were collected via face-to-face or telephone interviews and medical record abstractions. A total of 10,184 participants were interviewed and had a medical record abstracted during this period. Medical records were abstracted for the two years preceding a respondent's interview. A

more detailed description of the MMP methods is provided elsewhere (6). In 2013, response rates were 100% among states/territories, 85.0% among facilities and 54.9% among participants with both interview and medical record abstraction (MRA data). In 2014, response rates were 100% (states/territories), 86.5% (facilities), and 55.7% (participants). Information on diagnoses, medications, and blood pressure readings were collected during MRAs.

## Measurements

Hypertension was defined using three criteria: diagnosis (documented diagnosis of hypertension), treatment (prescription of antihypertensive medication) and high blood pressure readings (an average of the last two systolic blood pressures  $\geq 140$  mm Hg or diastolic readings  $\geq 90$  mm Hg). These criteria were combined such that a participant was classified as hypertensive if they met both diagnosis and treatment criteria or they met high blood pressure reading criteria. Hypertension was categorized as “undiagnosed and untreated”, “diagnosed and treated”, and “unclassified”. Patients who were “diagnosed and treated” were further classified as controlled or uncontrolled. [Supplementary appendix figure]

If a diagnosis of hypertension (or synonyms such as “high blood pressure”, and “essential hypertension”) was abstracted from the medical records, the respondent met the diagnosis criterion. Respondents who had no diagnoses of any kind abstracted (for example participants for whom a detailed MRA could not be conducted), were considered missing diagnosis information.

An extensive list of antihypertensive medication was used to classify respondents for the treatment criterion (Supplementary appendix 1). Respondents who had no medications of any kind abstracted were considered to be missing treatment information.

Respondents were classified as having high blood pressure readings based on the average of the last two readings. Those who had only one set of blood pressure readings or those who had no blood pressure documented were considered to be missing blood pressure information.

Respondents who had hypertension were sub-classified as follows:

Undiagnosed and untreated hypertension - met high blood pressure readings criterion but not diagnosis and treatment criteria

Treated and controlled hypertension - met diagnosis and treatment criteria but not the high blood pressure readings criterion

Treated and uncontrolled hypertension - met all three criteria

Unclassified hypertension - respondents who did not fall into any of the above categories and were missing information on any of the three criteria, or who met treatment and high blood pressure readings criteria but did not have a diagnosis (because antihypertensives can also be used to treat other conditions).

## **Data analyses**

Respondents were excluded if there was not enough information to classify them as hypertensive or non-hypertensive using the aforementioned three criteria. We estimated the weighted prevalence and associated 95% confidence intervals (CI) of hypertension, overall and by subcategory (undiagnosed and untreated, treated and controlled, treated and uncontrolled, and unclassified). We estimated the prevalence of overall, and undiagnosed and untreated hypertension stratified by sociodemographic, behavioral, and clinical characteristics. Rao-Scott chi-square tests were used to assess differences in the prevalence of hypertension by characteristics. Data were weighted for unequal selection probabilities and non-response.

In accordance with the federal human subjects protection regulations at 45 Code of Federal Regulations 46.101c and 46.102d (7) and with the Guidelines for Defining Public Health Research and Public Health Non-Research (8), MMP was determined to be a non-research, public health surveillance activity used for disease control program or policy purposes. As such, MMP is not subject to federal investigational review board review. Participating states or territories and facilities obtained local institutional review board approval to conduct MMP if required locally. Informed consent was obtained from all interviewed participants.

## **Results**

The analytic sample included 8,631 persons. Overall, 42.4% (95% CI 40.4-44.5) of PLWH in medical care had hypertension. Of those, 13.3% (95% CI 11.7-14.9) were undiagnosed and untreated, 48.9% (95% CI 46.7-51.1) were treated and controlled, 26.3% (95% CI 24.2-28.3) were treated and uncontrolled, and 11.5% (95% CI 10.4-12.6%) were unclassified.

Hypertension was associated with age, gender, race/ethnicity, education, income and BMI (Table). For example, hypertension was more prevalent among PLWH aged  $\geq 50$  years than among younger age groups. About half of non-Hispanic blacks had hypertension compared with 38.9% of non-Hispanic whites and 33.5% of Hispanics/Latinos.

The prevalence of undiagnosed and untreated hypertension decreased with increasing age: 39.1%, 27.0%, 16.2% and 9.4% among PLWH aged 18-29, 30-39, 40-49, and  $\geq 50$  years, respectively. There were no significant differences in the prevalence of untreated hypertension by race/ethnicity. Undiagnosed and untreated hypertension was more prevalent among recently incarcerated patients (25.7%) than among others (12.8%). PLWH who had no health insurance had a higher prevalence of untreated hypertension than those with health coverage. Undiagnosed and untreated hypertension was more prevalent among PLWH who were not virally suppressed at last test (17.0%) than among those who were (12.4%), and though not statistically significant, was more prevalent among those who did not have a sustained viral suppression over the past 12 months (15.9%) than among those who had a sustained viral suppression (12.1%).

## Discussion

The prevalence of hypertension among people receiving HIV care in the United States was 42.4%, which is within the range of previously published estimates (13.0%-49.0%) (3, 4, 9, 10). We found that about 1 in 8 patients had undiagnosed and untreated hypertension. Providers may be missing opportunities for diagnosing and treating hypertension among patients who are younger, male, uninsured, and recently incarcerated. Since PLWH may be at increased risk for

hypertension and its complications, including CVD, the importance of hypertension screening by providers, with the intent to effectively treat, cannot be over-emphasized.

While the proportion with hypertension was lowest among younger patients (aged 18-29 years), they were more than 4 times as likely to be undiagnosed and untreated as older patients (aged  $\geq 50$  years). Because young PLWH are least likely to be virally suppressed (11), it is possible that providers are more focused on attaining viral suppression than addressing comorbidities, such as hypertension, in this group. With PLWH living longer lives as a result of highly active antiretroviral therapy (12), younger patients with undiagnosed and untreated hypertension potentially have many years to accrue complications of untreated and uncontrolled hypertension and therefore would benefit from early diagnosis and treatment.

Patients who experience difficulty accessing health care such as those who were recently incarcerated or have no health insurance were more likely than others to have undiagnosed and untreated hypertension. We found that patients who were not virally suppressed at last test were more likely to have their hypertension undiagnosed and untreated. Because HIV viremia is associated with increased risk of CVD (13), patients with undiagnosed and untreated hypertension who are not virally suppressed may have compounded risk for CVD. These patients may need additional support to ensure that their HIV infection and comorbidities are successfully managed.

This study has limitations. We were unable to directly compare hypertension prevalence among PLWH (42%) with prevalence in the general US population (29%) as measured by the National



Health and Nutrition Examination Survey (14) because of methodologic differences between the 2 population surveys. We were conservative in our definition of hypertension by requiring both diagnosis and pharmacological treatment or high blood pressure readings, therefore, our prevalence may represent an underestimation of burden of hypertension among PLWH. MMP data do not indicate whether a patient is receiving lifestyle modification counseling. If this information were available and we had considered lifestyle modification as treatment, our estimates of the overall prevalence of hypertension and the prevalence of those who were “treated and uncontrolled,” or “treated and controlled” might have been higher. Similarly, our estimate of the prevalence of untreated hypertension might have been lower.

In conclusion, PLWH who received medical care in the United States had a high prevalence of hypertension. Providers may be missing opportunities to diagnose and treat hypertension among their HIV patients, especially those who are younger or have less access to care. It is important to improve hypertension screening and management to prevent CVD outcomes for which PLWH have high risk.

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**Table: Sociodemographic and Clinical Characteristics of HIV-infected Adults with Hypertension in the United States, Medical Monitoring Project 2013-2014**

	Total		Rao Scott Chi-square	Undiagnosed and Untreated		Rao Scott Chi-square
Characteristics	Sample size, N	Weighted % (95% CI)	P value	Sample size with hypertension, N	Weighted % (95% CI)	P value
<b>Total</b>	<b>8631</b>	42.4 (40.4-44.5)	n/a	<b>3650</b>	13.3 (11.7-14.9)	n/a
<b>Age (years)*</b>			<0.001			<0.001
18-29	720	10.7 (8.0-13.4)		80	39.1 (25.2-53.0)	
30-39	1326	23.1 (18.8-27.3)		308	27.0 (20.7-33.3)	
40-49	2520	37.0 (33.8-40.3)		927	16.2 (13.9-18.6)	
≥50	4065	58.5 (55.8-61.3)		2335	9.4 (7.7-11.2)	
<b>Gender*</b>			<0.001			0.006
Male	6158	41.2 (39.1-43.2)		2525	14.4 (12.6-16.3)	
Female	2353	46.3 (43.2-49.4)		1076	10.8 (8.6-13.1)	
Transgender	120	37.1 (28.3-45.9)		49	6.5 (0.2-12.9)	
<b>Race/Ethnicity*</b>			<0.001			0.059
White non-Hispanic	2498	38.9 (36.7-41.1)		956	15.3 (12.4-18.3)	
Black non-Hispanic	3693	49.8 (48.0-51.7)		1856	11.4 (9.1-13.6)	
Hispanic/Latino <sup>a</sup>	2079	33.5 (31.1-36.0)		700	15.4 (11.9-18.9)	
Other	361	39.6 (32.8-46.4)		138	15.0 (8.4-21.6)	
<b>Homeless<sup>b</sup> (past 12 months)*</b>			0.027			0.174
No	7899	42.8 (40.6-45.1)		3365	13.1 (11.4-14.7)	
Yes	731	38.0 (34.7-41.3)		284	16.2 (11.5-21.0)	
<b>Poverty status<sup>c,*</sup></b>			0.001			0.018

Above poverty level	4070	41.2 (39.1-43.3)		1670	15.0 (12.7-17.3)	
At or below poverty level	4165	44.3 (41.8-46.7)		1831	11.8 (10.0-13.6)	
<b>Education*</b>			<0.001			0.045
<High school	1799	46.1 (43.5-48.7)		827	10.8 (8.0-13.5)	
High school <sup>d</sup>	2390	43.7 (41.1-46.4)		1036	12.2 (9.6-14.7)	
>High school	4438	40.2 (38.0-42.5)		1785	15.2 (12.6-17.7)	
<b>Incarceration (past 12 months)*</b>			0.024			0.001
No	8246	42.7 (40.6-44.8)		3513	12.8 (11.2-14.5)	
Yes	383	36.7 (32.0-41.5)		136	25.7 (16.2-35.1)	
<b>Health Insurance Coverage*</b>			<0.001			0.003
Any private insurance	2357	38.5 (36.0-41.0)		905	16.9 (13.3-20.5)	
Public insurance only	4856	47.5 (44.8-50.2)		2290	11.4 (9.9-12.9)	
RW only	1135	30.4 (26.4-34.5)		336	15.9 (12.3-19.5)	
No insurance	117	35.0 (24.6-45.5)		41	19.7 (9.6-29.9)	
Unspecified	152	48.3 (39.7-56.9)		72	10.6 (0.3-20.9)	
<b>Smoking status*</b>			0.273			0.042
Never smoked/former smoker	5397	42.8 (40.8-44.9)		2318	12.3 (10.5-14.1)	
Current smoker	3201	41.7 (39.2-44.3)		1317	15.1 (12.6-17.5)	
<b>BMI**</b>			<0.001			0.062
Underweight	192	32.2 (25.1-39.2)		59	11.9 (2.2-21.6)	
Normal/healthy weight	2613	31.7 (29.3-34.1)		832	13.7 (11.7-15.8)	
Overweight	2551	41.6 (39.3-43.9)		1064	14.6 (12.5-16.7)	
Obese	2032	60.2 (57.0-63.4)		1211	11.0 (9.1-12.9)	
<b>Lowest CD4 count (cells/<math>\mu</math>L) (past 12 months)**</b>			0.003			0.063

0-49	243	37.9 (31.2-44.6)		89	22.1 (12.2-32.0)	
50-199	860	37.0 (33.7-40.2)		325	15.5 (11.7-19.2)	
200-349	1444	43.1 (40.1-46.1)		625	12.1 (9.4-14.8)	
350-499	1883	42.9 (40.2-45.6)		805	13.4 (11.0-15.8)	
≥500	3863	43.7 (41.2-46.2)		1672	12.3 (10.1-14.5)	
<b>Virally suppressed at last test<sup>e, **</sup></b>			0.508			0.040
No	1068	41.1 (37.5-44.7)		438	17.0 (12.5-21.5)	
Yes	7063	42.4 (40.3-44.6)		2992	12.4 (10.7-14.1)	
<b>Sustained viral suppression<sup>f, **</sup></b>			0.026			0.057
No	2093	39.2 (36.5-42.0)		826	15.9 (12.6-19.3)	
Yes	6038	43.3 (40.9-45.8)		2604	12.1 (10.0-14.1)	

Abbreviations: ART, antiretroviral therapy; BMI, body mass index; CI, confidence interval; HIV, human immunodeficiency virus; N, sample size of each stratum of variables.

<sup>a</sup> Hispanics/Latinos could be of any race.

<sup>b</sup> McKinney-Vento definition of homelessness: living on the street, living in a shelter, living in a single-room-occupancy hotel, temporarily staying with friends or family, or living in a car. A person is categorized as homeless if that person lacks a fixed, regular, adequate night-time residence or has a steady night-time residence that is 1) a supervised publicly or privately operated shelter designed to provide temporary living accommodation, 2) an institution that provides a temporary residence for persons intended to be institutionalized, or 3) a public or private place not designed for or ordinarily used as a regular sleeping accommodation for human beings (e.g., in an automobile or under a bridge) (Stewart B. McKinney Homeless Assistance Act, 42 U.S.C. §11301, et seq; 1987).

<sup>c</sup> US Department of Health and Human Services. Available at: <http://aspe.hhs.gov/poverty/09poverty.shtml>.

<sup>d</sup> Includes general education development (GED) credential.

<sup>e</sup> HIV RNA undetectable or <200 copies/mL at last test.

<sup>f</sup> HIV RNA undetectable or <200 copies/mL at all tests in the last 12 months.

\*Variables obtained from interview. \*\* Variables obtained from medical records.