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Viral Rebound Among Persons With Diagnosed HIV Who Achieved Viral Suppression, United States

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Abstract

Background: Some persons who achieve viral suppression may later experience viral rebound, potentially putting them at risk for transmitting HIV. We estimate the prevalence of, and describe factors associated with, viral rebound among adults with diagnosed HIV in the United States who had ≥2 viral load tests in a 12-month period.

Setting: The Medical Monitoring Project is an annual cross-sectional survey about the experiences and needs of adults with diagnosed HIV sampled from the National HIV Surveillance System.

Methods: We analyzed interview and medical record data from 3 Medical Monitoring Project cycles spanning June 2015—May 2018. We analyzed viral load results from the 12-month period before the interview among persons with ≥2 viral load tests who achieved viral suppression. Data were weighted based on known probabilities of selection, adjusted for patient nonresponse, and poststratified to known population totals from the National HIV Surveillance System.

Results: Among those with ≥2 viral load tests who achieved viral suppression, 7.5% demonstrated viral rebound. In multivariable analyses, viral rebound was higher among non-Hispanic blacks, persons ages 18–39, persons with public insurance, persons recently experiencing homelessness, persons with higher numbers of viral load tests, persons who missed HIV care appointments, and persons with suboptimal adherence to antiretroviral therapy.

Conclusions: Viral rebound varied by sociodemographic and clinical characteristics. HIV providers can monitor persons at greatest risk for viral rebound and link patients with ancillary services or evidence-based interventions to help them remain virally suppressed. Our findings can inform strategies and interventions implemented under the Ending the HIV Epidemic initiative.

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Keywords

HIV infections; viral load; United States; public health surveillance; sustained virologic response; retention in care

INTRODUCTION

Persons with HIV who achieve and maintain an undetectable viral load have effectively no risk of sexually transmitting HIV.[1–4] HIV treatment as prevention emphasizes that adherence to antiretroviral therapy (ART) is key to sustaining viral suppression and preventing sexual transmission of HIV.[5] However, some persons who achieve viral suppression are unable to sustain an undetectable viral load and experience viral rebound. Depending on the frequency of receipt of care and viral load testing, these persons may be unaware that their viral load levels have rebounded to detectable levels, potentially putting them at risk for transmitting HIV to sexual partners. We aimed to estimate the prevalence of, and describe the factors associated with, viral rebound among adults with diagnosed HIV living in the United States who achieved viral suppression and had at least 2 viral load tests in a 12-month period. Identifying groups in need of additional support to maintain viral suppression may better inform prevention strategies and adherence messaging in support of the Ending the HIV Epidemic initiative.[6]

METHODS

The Medical Monitoring Project (MMP) is an annual cross-sectional survey that describes experiences and needs of persons with diagnosed HIV. MMP produces nationally representative estimates of behavioral and clinical characteristics of adults with diagnosed HIV living in the United States.[7] MMP data collection is part of routine public health surveillance and, thus, determined to be nonresearch.[8] Participating states or territories obtained local institutional review board approval to collect data, when required. Informed consent was obtained from all participants.

Briefly, MMP uses a 2-stage sampling method. During the first stage, 23 project areas were sampled from all states in the U.S., the District of Columbia, and Puerto Rico. During the second stage, simple random samples of persons with diagnosed HIV aged 18 years and older are drawn annually for each participating state/territory from the National HIV Surveillance System, a census of U.S. persons with diagnosed HIV. For this analysis, we combined data from the 2015–2017 data collection cycles. Data were collected via phone or face-to-face interviews and medical record abstractions from June 2015—May 2018.

All 23 sampled jurisdictions participated. Among sampled persons, response rates ranged from 40% to 46%, resulting in 11,914 persons with interview and/or medical record data. Viral load test results from the 12-month period before the interview were abstracted. We defined viral suppression as <200 copies of viral RNA/mL, viral rebound as having at least one detectable viral load ≥200 copies/mL following a suppressed result, and sustained viral suppression as having all tests <200 copies/mL. Our analytic objective was to assess viral rebound among persons who achieved viral suppression. Persons with fewer than 2 viral

load tests (n = 4009) did not have an opportunity to demonstrate viral rebound and were excluded from analysis. Among persons with 2 or more viral load tests during the 12 months before interview, persons who never achieved viral suppression (n = 373) were also excluded. Persons who "gained" viral suppression (n = 765)—that is, those with one or more unsuppressed viral loads followed by at least one suppressed viral load—were excluded, because they did not have sustained viral suppression for the entire 12-month period nor did they demonstrate viral rebound. Our final analytic subset (n = 6767) included 543 persons with documented viral rebound and 6224 persons with documented sustained viral suppression during the 12 months before interview (Fig. 1).

Data were weighted based on known probabilities of selection at state/territory and person levels, adjusted for patient nonresponse, and poststratified to known population totals from the National HIV Surveillance System by age, race/ethnicity, and gender.[9] We computed weighted prevalence and corresponding 95% confidence intervals (CIs) for all estimates. We estimated unadjusted prevalence ratios (PRs) with predicted marginal means to describe associations between viral rebound and selected sociodemographic, behavioral, and clinical characteristics among persons who achieved viral suppression and had at least one follow-up viral load test over a 12-month period. We conducted multivariable analyses to estimate PRs adjusted for other variables in the model. We excluded from multivariable analyses any variables with unadjusted *P*-values >0.10, any variables highly correlated with other variables (eg, gender was excluded in favor of the sexual behavior/orientation variable that encompasses gender), and variables with small cell sizes (eg, received drug/alcohol counseling or treatment). We used a multi-stage modeling procedure, whereby the first model included all variables that met the criteria described above. All variables with $P \leq 0.10$ in the initial model were included in the final model. All analyses accounted for complex survey sample design and unequal selection probabilities using the survey procedures in SAS or SAS-callable SUDAAN.[10,11]

RESULTS

Among U.S. adults with diagnosed HIV, 60.1% (95% CI: 57.9 to 62.3) had ≥2 viral load tests over a 12-month period (Fig. 1). The remaining 39.9% (95% CI: 37.7 to 42.1) with <2 viral load tests were excluded from further analysis. Of persons with ≥2 viral load tests, those who never achieved viral suppression (2.8%, 95% CI: 2.4 to 3.2) and those who had an initial unsuppressed viral load, but later achieved and maintained viral suppression (5.7%, 95% CI: 5.1 to 6.2) were excluded from our analyses. Persons who demonstrated viral rebound (3.9%, 95% CI: 3.4 to 4.4) and sustained viral suppression (47.8%, 95% CI: 46.1 to 49.5) were included in our analyses. Within this group, 92.5% (95% CI: 91.6 to 93.3) had documented sustained viral suppression and 7.5% (95% CI: 6.7 to 8.4) had documented viral rebound. Table 1 presents prevalence of viral rebound and unadjusted and adjusted PRs (aPRs) by sociodemographic, social determinants of health, clinical, and mental health/substance use characteristics.

Sociodemographic Characteristics

Viral rebound was higher among women (9.2%, 95% CI: 7.7 to 10.8; unadjusted PR = 1.31, 95% CI: 1.06 to 1.62) compared with men (7.0%, 95% CI: 6.1 to 8.0). Men who have sex with men had the lowest prevalence of viral rebound (6.0%, 95% CI: 5.1 to 6.9) compared with men who have sex with women only (9.3%, 95% CI: 7.2 to 11.3; PR = 1.55, 95% CI: 1.21 to 2.00) or women who have sex with men (9.3%, 95% CI: 7.6 to 10.9; PR = 1.55, 95% CI: 1.24 to 1.94). Viral rebound was significantly higher among non-Hispanic blacks (10.3%, 95% CI: 8.9 to 11.7; PR = 2.23, 95% CI: 1.76 to 2.82) and Hispanics/Latinos (7.3%, 95% CI: 6.1 to 8.6; PR = 1.59, 95% CI: 1.23 to 2.05) compared with non-Hispanic whites (4.6%, 95% CI: 3.7 to 5.5). Viral rebound was significantly higher among persons aged 18–29 years (13.3%, 95% CI: 10.0 to 16.5; PR = 2.01, 95% CI: 1.49 to 2.72) and 30–39 years (10.4%, 95% CI: 8.3 to 12.5; PR = 1.58, 95% CI: 1.26 to 1.99), compared with persons aged ≥50 (6.6%, 95% CI: 5.6 to 7.6).

Social Determinants of Health

Viral rebound was higher among persons with less than a high school education (9.9%, 95% CI: 7.8 to 11.9; PR = 1.61, 95% CI: 1.26 to 2.05) and persons with a high school education (9.0%, 95% CI: 7.3 to 10.6; PR = 1.46; 95% CI: 1.17 to 1.83) compared with those with more than a high school education (6.1%, 95% CI: 5.2 to 7.1). Persons with any private insurance had lower rates of viral rebound (5.1%, 95% CI: 4.3 to 5.9) compared with persons with public insurance only (8.9%, 95% CI: 7.8 to 10.1; PR = 1.75, 95% CI: 1.44 to 2.13) or persons who had Ryan White coverage only or were uninsured (8.7%, 95% CI: 6.3 to 11.2; PR = 1.71, 95% CI: 1.26 to 2.32). Persons living at or below the poverty level had a higher prevalence of viral rebound (10.0%, 95% CI: 8.7 to 11.3; PR = 1.80, 95% CI: 1.50 to 2.18) compared with persons living above the poverty level (5.5%, 95% CI: 4.7 to 6.3). Persons who reported being homeless in the past 12 months had a higher prevalence of viral rebound (14.5%, 95% CI: 10.8 to 18.3; PR = 2.06, 95% CI: 1.58 to 2.68) compared with persons who were not homeless (7.1%, 95% CI: 6.3 to 7.9). Persons who reported being incarcerated in the past 12 months had a higher prevalence of viral rebound (15.1%, 95% CI: 8.6 to 21.6; PR = 2.08, 95% CI: 1.35 to 3.19) compared with persons who were not incarcerated (7.3%, 95% CI: 6.5 to 8.1).

Clinical Characteristics

Viral rebound was higher among persons who attended a clinic receiving Ryan White HIV/AIDS Program funding (8.9%, 95% CI: 7.9 to 9.8; PR = 2.13, 95% CI: 1.66 to 2.73) than among persons who attended other clinics (4.2%, 95% CI: 3.2 to 5.1). Viral rebound was associated with the total number of viral load tests performed following the first suppressed test result, as persons with 2 (8.0%, 95% CI: 6.8 to 9.1; PR = 1.76, 95% CI: 1.41 to 2.19), 3 (10.2%, 95% CI: 8.3 to 12.1; PR = 2.25, 95% CI: 1.69 to 3.01), or 4 or more viral load tests (26.8%, 95% CI: 21.3 to 32.3; PR = 5.92, 95% CI: 4.47 to 7.85) were significantly more likely to demonstrate viral rebound compared with persons with only one test (4.5%, 95% CI: 3.6 to 5.5). Viral rebound was higher among persons who missed HIV care appointments (12.5%, 95% CI: 10.6 to 14.4; PR = 1.98, 95% CI: 1.63 to 2.39) compared with persons who did not miss any appointments (6.3%, 95% CI: 5.5 to 7.2). Viral rebound was significantly

higher among persons not currently taking ART (27.9%, 95% CI: 17.4 to 38.5; PR = 5.44, 95% CI: 3.50 to 8.44) and persons taking ART who reported less than 100% dose adherence in the past 30 days (11.0%, 95% CI: 9.5 to 12.5; PR = 2.14, 95% CI: 1.80 to 2.55) compared with persons taking ART who reported 100% dose adherence (5.1%, 95% CI: 4.3 to 5.9).

Mental Health and Substance Use

Viral rebound was higher among persons reporting symptoms consistent with depression in the past 2 weeks (10.4%, 95% CI: 8.4 to 12.4; PR = 1.52, 95% CI: 1.23 to 1.87) compared with persons who did not (6.9%, 95% CI: 6.1 to 7.7). Viral rebound was higher among persons who received mental health services (8.7%, 95% CI: 7.3 to 10.2; PR = 1.28, 95% CI: 1.05 to 1.56) than among persons who did not need and did not receive services (6.8%, 95% CI: 5.9 to 7.7). Persons who reported using stimulant drugs in the past 12 months (10.7%, 95% CI: 8.0 to 13.4; PR = 1.48, 95% CI: 1.14 to 1.93) had a higher prevalence of viral rebound compared with persons who did not report using stimulant drugs (7.2%, 95% CI: 6.4 to 8.1). Viral rebound was higher among persons with unmet need for drug or alcohol counseling or treatment services (15.8%, 95% CI: 8.2 to 23.4; PR = 2.24, 95% CI: 1.39 to 3.62) and persons who received services (11.7%, 95% CI: 9.0 to 14.5; PR = 1.66, 95% CI: 1.29 to 2.15) compared with persons who did not need and did not receive services (7.1%, 95% CI: 6.2 to 7.9).

Multivariable Analysis

In the preliminary multivariable model (results not shown), the following variables had $P > 0.10$ and were excluded from the final model: sexual behavior/orientation ($P = 0.34$), education ($P = 0.57$), poverty level ($P = 0.55$), incarceration ($P = 0.12$), depression ($P = 0.25$), and stimulant drug use ($P = 0.31$). The following factors were associated with higher likelihood of viral rebound at $P < 0.10$ after adjusting for other variables in the final model (Table 1): non-Hispanic black race (aPR = 1.50, 95% CI: 1.14 to 1.98; $P = 0.003$) compared with non-Hispanic white race; age 18–29 years (aPR = 1.36, 95% CI: 0.98 to 1.89; $P = 0.074$) and age 30–39 years (aPR = 1.28, 95% CI: 1.02 to 1.61; $P = 0.036$) compared with age 50 or higher; public health insurance coverage (aPR = 1.32, 95% CI: 1.07 to 1.61; $P = 0.008$) compared with any private insurance; homelessness (aPR = 1.39, 95% CI: 1.04 to 1.86; $P = 0.03$); receiving care at a clinic receiving Ryan White funding (aPR = 1.40, 95% CI: 1.08 to 1.83; $P = 0.011$); having 2 tests (aPR = 1.71, 95% CI: 1.37 to 2.13; $P < 0.001$), 3 tests (aPR = 2.30, 95% CI: 1.71 to 3.09; $P < 0.001$), or ≥4 viral load tests (aPR = 5.54, 95% CI: 4.13 to 7.44; $P < 0.001$) after the first virally suppressed test result compared with 1 test; missing HIV care appointments (aPR = 1.49, 95% CI: 1.21 to 1.83; $P < 0.001$), no current ART use (aPR = 5.34, 95% CI: 3.46 to 8.23; $P < 0.001$), and current ART use with less than 100% dose adherence (aPR = 1.88, 95% CI: 1.58 to 2.23; $P < 0.001$) compared with current ART use and 100% dose adherence.

Differences in Prevalence of Viral Rebound by State

The prevalence of viral rebound among adults with diagnosed HIV who achieved viral suppression varied from 4.5% (95% CI: 2.5 to 6.6) to 11.8% (95% CI: 7.3 to 16.4) across states participating in MMP (Table 2).

DISCUSSION

Among U.S. adults with HIV who achieved viral suppression and had at least one follow-up test over a 12-month period, we found that roughly 1 in 13 had documented viral rebound. Viral rebound was higher among populations disproportionally affected by HIV including non-Hispanic blacks and younger persons, mirroring findings in the literature.[12–21] Disparities in viral rebound by black race persisted after adjusting for other sociodemographic factors such as education, poverty level, homelessness, incarceration, and health insurance coverage. Non-Hispanic blacks were 1.5 times as likely to demonstrate viral rebound compared with non-Hispanic whites. Our findings are consistent with those from prior MMP data collection cycles where, despite improvements in viral suppression over time among all races, we saw disparities in viral suppression among non-Hispanic blacks that persisted after adjusting for other sociodemographic, behavioral, and clinical factors.[22,23] Providers should consider offering patients at highest risk for viral rebound targeted, evidence-based interventions associated with improved retention in care, ART adherence, and viral load outcomes.[24] Adherence interventions developed specifically for blacks and younger persons may need to be prioritized to eliminate disparities in viral rebound by race and age.

Consistent with prior research,[21,25–27] we identified several social determinants of health that were significantly associated with viral rebound in bivariate analyses. After adjusting for other variables, persons with public health insurance coverage only were significantly more likely to have documented viral rebound compared with persons with private insurance. Persons who had recently experienced homelessness were significantly more likely to have documented viral rebound compared with those who had not. To address viral rebound disparities in housing and health insurance coverage, current and new resources may be prioritized through existing programs, such as the Housing Opportunities for Persons with AIDS and the Ryan White HIV/AIDS Program, respectively.[28,29] Although Housing Opportunities for Persons with AIDS is the only federal program devoted to housing needs for persons with HIV, some jurisdictions may also have local programs that address housing needs. HIV providers can identify patients with housing instability or health insurance coverage issues and refer them to case managers or social workers for assistance with housing or help enrolling in health insurance, Ryan White coverage, or the AIDS Drug Assistance Program.

In addition to demographic and social determinants of health, we identified several clinical factors that were significantly associated with viral rebound after adjusting for other variables. Not surprisingly, we found that the number of viral load tests performed after the first virally suppressed test result was significantly associated with viral rebound. For example, persons with 4 or more viral load tests performed were 5.54 times as likely to demonstrate viral rebound compared with persons with only one test. This is likely explained by the frequency of viral load testing ordered by providers based on patient-specific factors related to past ART adherence and the ART regimen prescribed. For example, providers may order less frequent viral load testing for persons with a history of sustained viral suppression and adherence to HIV care and treatment, whereas more frequent viral load testing may be an indicator of previous non-adherence with care and/or treatment

or more complicated treatment regimens. In addition, we found that persons who self-reported no current ART use or recent suboptimal adherence to ART and persons who missed HIV care appointments were significantly more likely to have documented viral rebound. These associations with suboptimal viral load outcomes among factors on the HIV care continuum are consistent with the literature.[17,30–32] It is important for HIV providers to provide ongoing adherence counseling and screen for barriers to maintaining viral suppression, even among patients who are virally suppressed. Providers may consult the Centers for Disease Control and Prevention's Compendium of Evidence-Based Interventions and Best Practices for HIV Prevention,[24,33] which offers examples of numerous structural (eg, financial incentives) and medication adherence interventions (eg, Project NGage) associated with improved retention in care, ART adherence, and viral load outcomes. Interventions are characterized by target population, intervention level (group or individual), and ART use history (treatment-experienced or treatment-naive). Finally, tailored HIV adherence and prevention messaging in conjunction with enhanced treatment adherence interventions may be needed to sustain viral suppression among persons at highest risk for viral rebound. The Health Resources and Services Administration recently stressed the importance of viral suppression messaging in medical and nonmedical settings, and urged HIV care and ancillary service providers to incorporate tailored messages about viral suppression into routine clinical practice.[34] Enhanced focus on viral load monitoring among those at highest risk for viral rebound, referrals to case management to address unmet needs, and delivery of tailored adherence messages and interventions may further reduce disparities in viral rebound.

Limitations

One limitation of our analysis is that we excluded persons with <2 viral load tests, persons without documented viral suppression, and persons who gained viral suppression, resulting in an analytic subset of persons who achieved viral suppression and had ≥2 viral load tests in a 12-month period, who represent an estimated 52% of adults with diagnosed HIV in the United States. However, our primary aim was to estimate the prevalence of viral rebound and describe factors associated with viral rebound among adults who achieved viral suppression. Our analytic subset was similar to the overall MMP sample on sociodemographic characteristics. Because of small sample sizes, we were unable to conduct state-level multivariable analyses. However, factors independently associated with viral rebound may vary by state and could be the focus of future analyses to help state or local public health programs identify populations at highest risk for viral rebound. Second, we could only assess viral rebound when persons sought care and had viral load testing done, so our findings may not apply to persons who dropped out of care. Third, we abstracted medical records from the facility where the person reported receiving most of his/her care in the 12 months before the interview, therefore potentially missing viral load tests from persons receiving care at multiple facilities. Finally, some of the interview measures that anchored closely in time to the interview date (eg, adherence within the past 30 days or depression symptoms in the past 2 weeks) are not contemporaneous with the timing of all viral load tests conducted up to 12 months earlier, so we cannot assess or infer causality.

CONCLUSION

While the overall prevalence of documented viral rebound was only 7.5%, our analyses highlighted several populations (non-Hispanic blacks, younger persons, and those recently experiencing homelessness) disproportionately affected by viral rebound. Our findings may help inform which groups to prioritize under the "Treat" pillar of the Ending the HIV Epidemic Initiative[6] and may help researchers tailor adherence strategies and interventions or adherence messaging to different populations. We confirmed several proximal clinical and behavioral factors to be associated with viral rebound, such as suboptimal adherence to ART, missed clinic appointments, and number of viral load tests. A more complete understanding of the factors associated with viral rebound may help HIV providers better identify and more closely monitor persons at greatest risk for viral rebound. Through assessing and identifying barriers to care and unmet needs, providers can link patients with ancillary services and evidence-based interventions to help them stay in care, adhere to ART treatment as prescribed, and remain virally suppressed.

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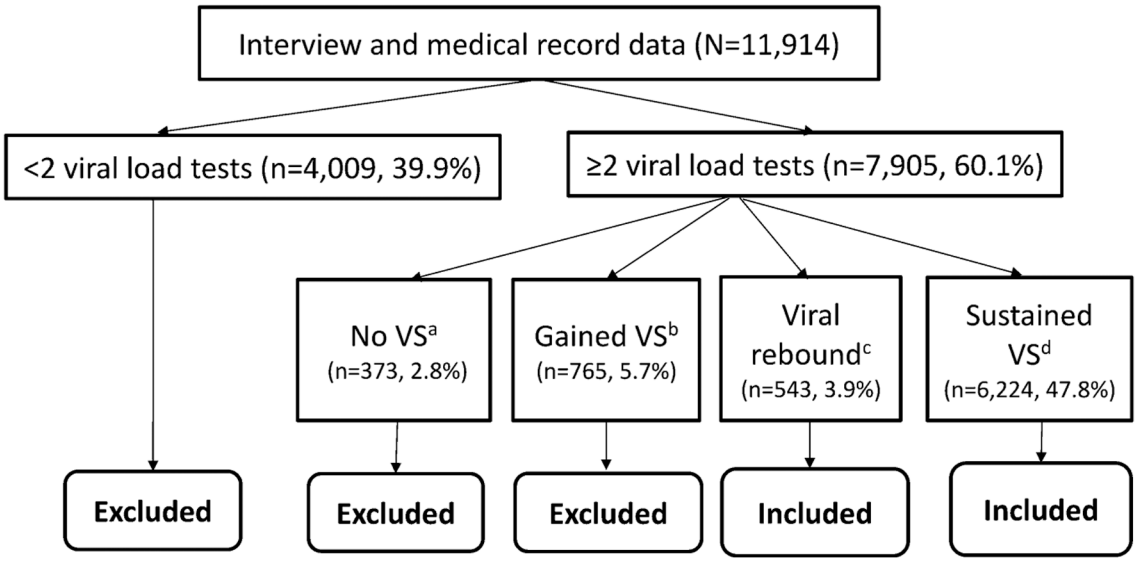

Abbreviations: VS, viral suppression
Numbers are unweighted. Percentages are weighted estimates.
[a] No HIV viral load measurements documented undetectable or <200 copies/mL in the 12 months preceding the interview.
[b] HIV viral load test(s) documented ≥ 200 copies/mL followed by ≥1 viral load tests documented <200 copies/mL for the duration of the 12-month period preceding the interview.
[c] At least 1 viral load test ≥ 200 copies/mL following an undetectable or <200 copies/mL result, in the 12 months preceding the interview.
[d] All HIV viral load measurements documented undetectable or <200 copies/mL in the 12 months preceding the interview.

FIGURE 1.

Defining the analytic subset comparing persons with documented viral rebound versus persons with sustained viral suppression, MMP, 2015–2017 (n = 6767).

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TABLE 1.

Viral Rebound[*] Among Adults With Diagnosed HIV Who Achieved Viral Suppression[†], MMP, 2015–2017 (N = 6,767[‡])

	Viral rebound[*]		Unadjusted Results			Adjusted Results		
	n[§]	Row % (95% CI)[‖]	Prevalence Ratio (95% CI)[‖]	*P*	*P* (Wald F)	Prevalence Ratio (95% CI)[‖]	*P*	*P* (Wald F)
Total	543	7.5 (6.7 to 8.4)						
Sociodemographic characteristics								
Gender					**0.014**			
Male	368	7.0 (6.1 to 8.0)	Reference					
Female	165	9.2 (7.7 to 10.8)	1.31 (1.06 to 1.62)	0.014				
Sexual behavior/orientation[¶]					<**0.001**			
Men who have sex with men	210	6.0 (5.1 to 6.9)	Reference					
Men who have sex with women only	149	9.3 (7.2 to 11.3)	1.55 (1.21 to 2.00)	<0.001				
Women who have sex with men	161	9.3 (7.6 to 10.9)	1.55 (1.24 to 1.94)	<0.001				
Race and ethnicity					<**0.001**			**0.005**
White (Non-Hispanic)	102	4.6 (3.7 to 5.5)	Reference			Reference		
Black (Non-Hispanic)	283	10.3 (8.9 to 11.7)	2.23 (1.76 to 2.82)	<0.001		1.50 (1.14 to 1.98)	0.003	
Hispanic or Latino[#]	131	7.3 (6.1 to 8.6)	1.59 (1.23 to 2.05)	<0.001		1.12 (0.85 to 1.47)	0.416	
Other/Multiracial[**]	27	6.4 (4.0 to 8.7)	1.38 (0.92 to 2.06)	0.122		0.98 (0.61 to 1.57)	0.941	
Age (yr)					<**0.001**			**0.017**
18–29	65	13.3 (10.0 to 16.5)	2.01 (1.49 to 2.72)	<0.001		1.36 (0.98 to 1.89)	0.074	
30–39	112	10.4 (8.3 to 12.5)	1.58 (1.26 to 1.99)	<0.001		1.28 (1.02 to 1.61)	0.036	
40–49	112	6.5 (5.1 to 7.9)	0.98 (0.76 to 1.27)	0.904		0.95 (0.74 to 1.20)	0.650	
≥50	254	6.6 (5.6 to 7.6)	Reference			Reference		
Survey year					**0.238**			
2015	186	8.6 (7.0 to 10.1)	1.21 (0.92 to 1.60)	0.174				
2016	171	7.1 (5.9 to 8.2)	1.00 (0.76 to 1.30)	0.986				
2017	186	7.1 (5.6 to 8.6)	Reference					
Social determinants of health								
Education					<**0.001**			
<High school	136	9.9 (7.8 to 11.9)	1.61 (1.26 to 2.05)	<0.001				

	Viral rebound*		Unadjusted Results			Adjusted Results		
	n§	Row % (95% CI)‖	Prevalence Ratio (95% CI)‖	*P*	*P* (Wald F)	Prevalence Ratio (95% CI)‖	*P*	*P* (Wald F)
High school diploma or equivalent	161	9.0 (7.3 to 10.6)	1.46 (1.17 to 1.83)	0.001				
>High school	245	6.1 (5.2 to 7.1)	Reference					
Health care coverage					<**0.001**			**0.019**
Any private insurance	127	5.1 (4.3 to 5.9)	Reference			Reference		
Public insurance only	359	8.9 (7.8 to 10.1)	1.75 (1.44 to 2.13)	<0.001		1.32 (1.07 to 1.61)	0.008	
Ryan White coverage only/Uninsured	52	8.7 (6.3 to 11.2)	1.71 (1.26 to 2.32)	0.001		1.03 (0.74 to 1.44)	0.857	
Poverty levels††					<**0.001**			
Above poverty level	211	5.5 (4.7 to 6.3)	Reference					
At or below poverty level	293	10.0 (8.7 to 11.3)	1.80 (1.50 to 2.18)	<0.001				
Homeless‡‡					<**0.001**			**0.030**
Yes	72	14.5 (10.8 to 18.3)	2.06 (1.58 to 2.68)	<0.001		1.39 (1.04 to 1.86)	0.030	
No	470	7.1 (6.3 to 7.9)	Reference			Reference		
Incarcerated					**0.001**			
Yes	41	15.1 (8.6 to 21.6)	2.08 (1.35 to 3.19)	<0.001				
No	501	7.3 (6.5 to 8.1)	Reference					
Clinical characteristics								
Receives care at a clinic receiving Ryan White funding					<**0.001**			**0.011**
Yes	448	8.9 (7.9 to 9.8)	2.13 (1.66 to 2.73)	<0.001		1.40 (1.08 to 1.83)	0.011	
No	85	4.2 (3.2 to 5.1)	Reference			Reference		
Total number of viral load tests after first suppressed result					<**0.001**			<**0.001**
1 test	150	4.5 (3.6 to 5.5)	Reference			Reference		
2 tests	206	8.0 (6.8 to 9.1)	1.76 (1.41 to 2.19)	<0.001		1.71 (1.37 to 2.13)	<0.001	
3 tests	108	10.2 (8.3 to 12.1)	2.25 (1.69 to 3.01)	<0.001		2.30 (1.71 to 3.09)	<0.001	
4 or more tests	79	26.8 (21.3 to 32.3)	5.92 (4.47 to 7.85)	<0.001		5.54 (4.13 to 7.44)	<0.001	
Time since HIV diagnosis					**0.368**			
< 5 yrs	77	7.1 (5.5 to 8.8)	Reference					
5–9 yrs	108	6.7 (5.2 to 8.3)	0.94 (0.69 to 1.29)	0.714				
≥10 yrs	358	7.9 (6.9 to 9.0)	1.11 (0.86 to 1.44)	0.420				

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	Viral rebound*		Unadjusted Results			Adjusted Results		
	n§	Row % (95% CI)‖	Prevalence Ratio (95% CI)‖	*P*	*P* (Wald F)	Prevalence Ratio (95% CI)‖	*P*	*P* (Wald F)
Missed any HIV care appointments					<**0.001**			<**0.001**
Yes	193	12.5 (10.6 to 14.4)	1.98 (1.63 to 2.39)	<0.001		1.49 (1.21 to 1.83)	<0.001	
No	347	6.3 (5.5 to 7.2)	Reference			Reference		
ART use and ART dose adherence§§					<**0.001**			<**0.001**
No current ART use	27	27.9 (17.4 to 38.5)	5.44 (3.50 to 8.44)	<0.001		5.34 (3.46 to 8.23)	<0.001	
Current ART use, not 100% adherent	279	11.0 (9.5 to 12.5)	2.14 (1.80 to 2.55)	<0.001		1.88 (1.58 to 2.23)	<0.001	
Current ART use, 100% adherent	232	5.1 (4.3 to 5.9)	Reference			Reference		
Mental health and substance use								
Depression (past 2 weeks)‖‖					<**0.001**			
No depression	405	6.9 (6.1 to 7.7)	Reference					
Any depression¶¶	133	10.4 (8.4 to 12.4)	1.52 (1.23 to 1.87)	<0.001				
Received mental health services					**0.050**			
Needed, but did not receive	46	7.7 (5.3 to 10.1)	1.12 (0.82 to 1.54)	0.470				
Received	202	8.7 (7.3 to 10.2)	1.28 (1.05 to 1.56)	0.015				
Did not need and did not receive	288	6.8 (5.9 to 7.7)	Reference					
Any drug use					**0.861**			
Yes	154	7.6 (6.2 to 9.1)	1.02 (0.83 to 1.25)	0.861				
No	383	7.5 (6.6 to 8.4)	Reference					
Any stimulant drug use##					**0.004**			
Yes	69	10.7 (8.0 to 13.4)	1.48 (1.14 to 1.93)	0.004				
No	468	7.2 (6.4 to 8.1)	Reference					
Received drug or alcohol counseling or treatment					<**0.001**			
Needed, but did not receive	16	15.8 (8.2 to 23.4)	2.24 (1.39 to 3.62)	0.002				
Received	63	11.7 (9.0 to 14.5)	1.66 (1.29 to 2.15)	<0.001				
Did not need and did not receive	458	7.1 (6.2 to 7.9)	Reference					
Binge drinking (past 30 days)***					**0.163**			
Yes	97	8.7 (6.7 to 10.7)	1.18 (0.94 to 1.49)	0.163				
No	440	7.3 (6.5 to 8.2)	Reference					

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All variables measured by self-report over the past 12 months except where otherwise noted. Numbers might not add to total because of missing data. Percentages may not sum to 100 because of rounding. All variables with unadjusted $P < 0.10$ were considered for inclusion in multivariable analyses. For highly collinear variables (eg, gender & sexual behavior/orientation), only one variable was included in multivariable analyses.

[*] Viral load measurement of ≥200 copies/mL documented in the 12 months preceding the interview.

[†] Among persons with >1 viral load test in the 12 months preceding the interview.

[‡] Among persons categorized as demonstrating “sustained viral suppression” or “viral rebound.”

[§] Numbers are unweighted.

[‖] Percentages and corresponding CIs are weighted percentages.

[¶] Persons were classified based on sexual behavior among the sexually active and reported sexual orientation among the nonsexually active.

[#] Hispanics or Latinos may be of any race. Persons are classified in only one race category.

[**] Includes American Indian/Alaska native, Asian, native Hawaiian/other Pacific Islander, or multiple races.

[††] Poverty guidelines as defined by the Department of Health and Human Services (DHHS). More information regarding DHHS poverty guidelines can be found at http://aspe.hhs.gov/frequently-asked-questions-related-poverty-guidelines-and-poverty.

[‡‡] Living on the street, in a shelter, in a single-room-occupancy hotel, or in a car.

[§§] Among those taking ART.

[‖‖] Based on responses to items on the Patient Health Questionnaire (PHQ-8). Kroenke K, Strine TW, Spritzer RL et al. The PHQ-8 as a measure of current depression in the general population. J Affect Disord. 2009; 114(1–3):163–73.

[¶¶] Reported 2 or more symptoms of depression based on PHQ-8 items.

[##] Injection or non-injection use of methamphetamines, amphetamines, crack, cocaine, or injected heroin.

[***] Binge drinking was defined as having ≥ 5 alcoholic beverages in a single sitting (≥4 for women) on at least 1 day during the 30 days before the interview.

TABLE 2.

Prevalence of Viral Rebound by State[*] Among Adults With Diagnosed HIV Who Achieved Viral Suppression, MMP, 2015–2017 (n = 6767)[†]

	n[‡]	Row % (95% CI)[§]
Total	543	7.5 (6.7 to 8.4)
California	47	5.3 (3.6 to 7.0)
Delaware	30	8.9 (5.8 to 12.1)
Florida	46	8.5 (5.9 to 11.2)
Georgia	32	10.7 (6.9 to 14.4)
Illinois	31	7.6 (4.9 to 10.3)
Indiana	9	5.3 (1.8 to 8.9)**
Michigan	22	7.6 (4.5 to 10.8)
Mississippi	29	11.8 (7.3 to 16.4)
New Jersey	29	9.7 (5.8 to 13.6)
New York	74	9.7 (7.5 to 11.9)
North Carolina	16	4.8 (2.4 to 7.1)
Oregon	19	4.5 (2.5 to 6.6)
Pennsylvania	32	6.5 (4.0 to 8.9)
Puerto Rico	40	8.8 (5.8 to 11.7)
Texas	51	8.5 (5.8 to 11.2)
Virginia	22	7.1 (4.0 to 10.2)
Washington	14	5.4 (2.6 to 8.3)

Estimates marked with an double asterisk have a coefficient of variation ≥0.30 and may be unstable.

[*] 16 states and Puerto Rico are represented. Data collected from the 6 MMP city/county jurisdictions (Chicago, Houston, Los Angeles County, New York City, Philadelphia, and San Francisco) are included in the corresponding state.

[†] Viral rebound (viral load measurement of ≥200 copies/mL) among persons with >.1 viral load test documented in the 12 months preceding the interview.

[‡] Numbers are unweighted.

[§] Percentages and corresponding CIs are weighted percentages.