

CHAIN Report 2017-2



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# Determinants of Viral Suppression in the CHAIN Cohort

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Peter Messeri  
Kelly Carmody  
Katherine Penrose

Columbia University  
Mailman School of Public Health  
In collaboration with the NYC Department of Health and  
Mental Hygiene, the Westchester Department of Health,  
the HIV Health and Human Services Planning Council of New  
York, and Public Health Solutions

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**Key Findings**

For the 2010-17 CHAIN interview period:

- Laboratory data indicated that 77% of NYC CHAIN participants and 78% of Tri-County CHAIN participants were virally suppressed (defined as having viral load  $\leq 200$  copies/mL) at the time CHAIN interviews were conducted.
- 86% of NYC CHAIN participants and 87% of Tri-County participants reported that they were completely adherent to their ART regimen.
- Viral suppression for the combined CHAIN cohorts was independently associated with adherence to a recommended ART regimen, older age, being a man who has/had sex with other men, stable housing, nutritional counseling and continuous engagement in medical care.
- Current drug use and use of medical case management services were negatively associated with viral suppression.

**Background: National and Local Trends in Viral Suppression**

The attainment of viral suppression among persons living with HIV (PLWH) is a cornerstone of efforts to end the HIV epidemic. After many years of minimal progress towards achieving this goal, viral suppression in the U.S. has substantially increased in recent years. National estimates of viral suppression for studies conducted as recently as 2011 ranged between 19% and 30% (CDC 2012; Bradley et al. 2014). Among United States residents living with HIV/AIDS who were *treated with ART*, viral suppression improved from 45% in 2001 to 72% in 2010 (Amico and Orrell 2012). In 2011, 72.6% of recipients of Ryan White services who had *at least one HIV medical care visit* achieved viral suppression (Doshi et al. 2015). For a national sample of PLWH for the CDC's 2015-2016 Medical Monitoring Project (MMP), 62.5% reported sustained viral suppression (viral load <200 copies/mL on all viral load measurements in the 12 months preceding the interview), and 70% were virally suppressed at the most recent assessment (CDC 2018). As a further point of comparison, 65% of the estimated 121,900 New York State residents living with HIV at the end of 2016 were estimated to be virally suppressed, as were 87% of those receiving *any HIV medical care* (NYS DOH 2018). These improvements are partially attributable to the introduction of newer generations of more effective and simplified ART regimens, coupled with supportive services that promote engagement in care, such as those funded through the Ryan White HIV/AIDS program. A further impetus to recent increases in viral suppression was a revision to NYC Department of Health and Mental Hygiene (NYC DOHMH) HIV treatment guidelines in December 2011 (and CDC guidelines in March 2012) recommending initiation of ART as soon as possible after diagnosis.

*Correlates of Viral Suppression*

Research documents that several social factors are strongly associated with viral suppression. Black PLWH had lower rates of viral suppression than other racial/ethnic groups in studies by Doshi et al. (2015), Greenberg et al. (2015) and the 2015-2016 MMP (CDC 2018), but not in the earlier 2011 MMP (Bradley et al. 2014). Despite well-established gender differences in health, viral suppression appears to be similar for HIV-infected men and women (CDC 2018). Perhaps the most robust finding involving demographic characteristics is a positive correlation between viral suppression and older age (Bradley et al. 2014; Doshi et al. 2015). Age differences in viral suppression may be a consequence of social and/or developmental differences in medication-taking behaviors. Greater suppression among older PLWH may also reflect selective

survival to older age, e.g., as a consequence of life-long differences in access to social and economic resources that are beneficial to health and/or differences in mastery of skills that support sustained medication adherence.

A further dimension of social disadvantage, unstable housing, has also been shown to be associated with lower rates of viral suppression (Galarraga et al. 2018; Kidder et al. 2007; Loh et al. 2016; Marshall et al. 2016; Muthlingham, et al. 2013; Terzian et al. 2015). Galarraga et al. (2018) have identified three mechanisms that may explain this relationship. Housing concerns may disrupt efforts to engage in medical care in general and to maintain medication adherence in particular (cf. Kidder et al. 2007). Unstable housing as a chronic stressor may adversely affect health by weakening immune system functioning. Finally, the link between reduced viral suppression and unstable housing may also be a consequence of its association with other chronic stressors such as low income and long-term unemployment.

However, it remains uncertain whether provision of stable or specialized housing improves HIV outcomes among unstably housed individuals. On the one hand, Marshall et al. (2016) imputed the effect of eliminating homelessness on viral suppression for a prospective cohort of PLWH using substances. They estimated that viral suppression would increase from 37.8% to 43.5%, were all homeless individuals in the study population stably housed. An RCT evaluated the health impact of permanent housing combined with intensive case management for a sample of 105 HIV-positive homeless Chicago residents. This study found that 55% of the supportive housing group compared to 34% of the usual care group had undetectable viral load after a year. (Buchanan, Kee, Sadowski & Garcia 2018). On the other hand, NYC recipients of specialized housing for low-income PLWH (HOPWA) were more likely than PLWH in other types of housing to be retained in medical care, but were no more likely to achieve viral suppression (Terzian et al. 2015). A multi-site study randomizing unstably housed participants to HOPWA rental assistance or to customary housing services found that study participants receiving HOPWA rental assistance were more likely than the control group to be stably housed at 6-, 18- and 12- month follow-up, but were neither more adherent to ART medications, nor more likely to be virally suppressed than the comparison group at successive follow-up periods (Wolitski et al. 2010).

Mixed results have also been reported for the effects of case management services. A 2010 Washington D.C. study found that, after adjusting for differences in patient demographics and clinical characteristics, patients in facilities with Ryan White-funded medical case management (MCM) programs were significantly more likely to be retained in care than a matched group of patients receiving care at non-MCM facilities. However, patients cared for in MCM-funded facilities were no more likely to be virally suppressed than patients receiving care at non-MCM funded facilities (Willis et al. 2013). NYC's HIV Care Coordination Program (CCP) combined case management with patient navigation, directly observed therapy, structured health promotion, and outreach to assist patients in accessing medical care. Among patients enrolled between December 2009 and March 2013, the CCP's impact on viral suppression depended upon baseline viral load status (Nash et al. 2018). Newly diagnosed enrollees and those previously diagnosed and virally unsuppressed throughout the year prior to study enrollment had significantly higher viral suppression at 12-month follow-up, as compared to a matched comparison group of PLWH who were eligible but not enrolled in CCP services. Among previously diagnosed study participants who were either consistently or inconsistently virally suppressed in the year prior to enrollment, there was no difference in viral suppression between the CCP clients and the non-enrolled comparison group (Nash et al. 2018).

The current study investigates the correlates of viral suppression for CHAIN participants residing in New York City and in the Tri-County region to the north of the City (Putnam, Westchester, and Rockland counties). It investigates the association of viral suppression with a broad range of sociodemographic characteristics, health-related behaviors and conditions, needs for and use of health and human services, and features of medical care.

## **Methodology**

### *Data Sources*

Study data were obtained from CHAIN interviews conducted between 2010 and 2017 and viral load test results reported to City and State HIV surveillance registries between July 1, 2009 and June 30, 2018. The 2010-17 period coincided with the 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> rounds of interviews with the NYC cohort and the 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> rounds of interviews with Tri-County residents.<sup>1</sup> During this period, 2,870 interviews were completed with 1,462 unique participants.

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<sup>1</sup> Interviewing in Tri-County was temporarily suspended during the time of the 8<sup>th</sup> round of NYC interviews. An 8<sup>th</sup> round of Tri-County interviews coincided with the 9<sup>th</sup> round of NYC interviews.

Of this total, 2,260 interviews were conducted with 1,000 New York City residents, and 610 interviews were conducted with 462 Tri-County Residents.

### *Study Variables*

*Outcome Measure.* NYC viral load test results were obtained from the NYC DOHMH HIV/AIDS Surveillance Registry. Tri-County viral load test results were obtained from the New York State Department of Health surveillance data.<sup>1</sup> Registries were searched for CHAIN participants' viral load results closest in time to each of their interviews. A matched viral load had to be within the period six months prior to or six months after an interview. We were able to obtain matching viral load test results for 2,769, or 96%, of the CHAIN interviews conducted during the study period. After removing a small number of interviews with missing data for study variables, the sample for this study included 2,687 interviews (89% of all CHAIN interviews conducted during this period) with 1,378 CHAIN participants (94% of all CHAIN participants).

*Medication Adherence Measure.* Interviewers showed CHAIN participants a listing of all FDA-approved HIV antiretroviral medications, on a card that was updated at the start of each round of interviews. Interviewers asked participants to indicate which of the listed medications they were prescribed in the last six months and which they were currently taking. We determined whether all or a subset of antiretroviral medications that participants reported currently taking matched an antiretroviral medication combination recommended for treatment at the time of interview. If participants reported currently taking one or more HIV/AIDS medications, they were then asked: "How many of your HIV pills, that is your combination therapy, did you miss taking for any reason?", "Were you off schedule at all, that is late by one hour or more in taking any of your HIV pills?", and finally, "Over the last six months, which of the following best describes your general experience taking your medications?" Response options ranged from "I take them exactly as prescribed, almost never missing a dose" to "I rarely take my pills as prescribed." We then combined responses to these questions into a three-level ART adherence

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<sup>1</sup> New York State patient confidentiality rules prohibit disclosing individual HIV test results reported to the State and City to third parties. Therefore, Columbia University staff created a CHAIN data set that included personal identifying information (full names, dates of birth, social security numbers). This data set was conveyed by the CHAIN team to DOHMH through a secure web-based file transfer system (Biscom). Under the direction of K. Penrose, DOHMH staff matched the CHAIN interview data to individual NYC lab data and to New York State surveillance data for Tri-County. K. Penrose then performed statistical analysis of the Registry data following P. Messeri's model specifications.

variable: 1) Taking a recommended ART combination exactly as prescribed, 2) taking a recommended ART combination but not completely adherent and 3) not taking a recommended ART combination. The latter group combines sample members taking a non-recommended ART combination and those not taking any ART medication.

*Other Independent Variables.* We organized the remaining study variables into the following broader domains: demographics, health-related behaviors and conditions, health and social services, and medical care features. In the latter domain, we included aspects of medical care quality that we hypothesized could improve health outcomes: access to comprehensive primary care, satisfaction with medical care received, continuity of medical care, and a summative scale of the receipt of recommended HIV medical tests and procedures (HIV Medical Procedures Scale). We also investigated whether having either a paid or an unpaid companion accompany an individual to medical visits improved viral suppression.

Table 1 displays operational definitions for other independent variables included in this study.

**Table 1: Operational Definitions of Study Variables**

Education	Formal Educational Attainment (coded values shown to the left of the labels) <ol style="list-style-type: none"> <li>1. Less than High School</li> <li>3. Graduated High School</li> <li>5. Some College</li> <li>6. Undergraduate Degree</li> <li>7. Some Graduate School</li> </ol>
Problem Substance Use	Reported problem drinking in past six months OR use of crack/cocaine or heroin in past 12 months
Need For Mental Health Services	Scored $\leq 37$ on the Mental Health Summary Component Scale of the SF-12
Need for Housing Placement or Assistance	Was unstably housed or doubled up OR once in a while to very often didn't have sufficient money for rent OR had difficulty paying rent in past six months
Food Insecurity	Went without food for one or more days in last month OR had limited or no access to cooking facilities except for a hotplate
Need for Nutritional Counseling	Had BMI $\leq 18.5$ or BMI $\geq 25$ , diagnosed hypertension OR a diagnosed heart problem OR diagnosed diabetes OR diagnosed high cholesterol OR current pregnancy
Mental Health Services	Received any psychological or emotional counseling or therapy including talking to a pastor or religious counselor OR attended a support group in last six months OR was hospitalized for a psychiatric or mental health reason in last six months
Drug Treatment	Received any treatment for drug or alcohol use, including participation in any groups like AA or NA
Medical Case Management (sum of reported activities)	In the last six months, a case manager worked with you : <ol style="list-style-type: none"> <li>1. To get a referral for specific medical services</li> <li>2. To keep an appointment for medical care</li> <li>3. To develop a plan to take your HIV medications in the right way</li> </ol>

	4. To take your antiviral medications
Social Service Case Management (sum of reported activities)	In the last six months, received help from a case manager: <ol style="list-style-type: none"> <li>1. To revise or develop a plan for dealing with your needs</li> <li>2. With a referral for a specific social service need</li> <li>3. Including periodically checking on how you are doing or asking whether you are getting the services you need</li> <li>4. To fill out forms for benefits or entitlements</li> <li>5. To keep an appointment for social services</li> </ol>
Counseling Case Management (sum of reported topics)	Received counseling from a case manager about: <ol style="list-style-type: none"> <li>1. Your personal problems</li> <li>2. Drug or alcohol use</li> <li>3. How to practice safer sex</li> </ol>
Nutritional Counseling	Received one-on-one counseling about food and nutrition in last six months
Food Services	In the last six months, received food stamps OR meals in group setting OR home delivered meals OR free food from pantry
Housing Assistance	In the last six months, received (or knew that a household member received) money from one or more of the following: <ol style="list-style-type: none"> <li>1. Voucher, pass, ticket or coupon for a single night or week's stay</li> <li>2. Section 8 voucher or certificate to cover part of the rent on an apartment</li> <li>3. HOPWA, HASA, DASIS or AIDS housing assistance to cover part of the rent on an apartment</li> </ol> OR Lived in group housing, special needs housing or halfway house OR Received other form of rental assistance
Medication Adherence Services	Answered "Yes" to the question: Has anyone suggested ways to help you remember to take your HIV medicine on time and in the right way?
Comprehensive Primary Care	Answered "Yes" to all three parts of the question: During the last six months, has there always been someone you could 1) go to for routine check-ups or vaccinations or medical tests AND 2) go to for information, or advice about health concerns AND 3) call up 24 hours a day in case of a medical emergency?
Medical Provider Satisfaction Scale	Sum of the responses to the following items: <ol style="list-style-type: none"> <li>1) On average, your current medical provider spends enough time with you when you visit? (no=1) (yes=2)</li> <li>2) At your last medical care visit, do you feel that the provider understood what was bothering you?: didn't understand at all (1) to understood very well (4)</li> <li>3) At your last visit, how much interest and concern did your medical provider show to you: very unconcerned (1) to very concerned (4)</li> <li>4) Overall how satisfied are you with the medical care you get from your current provider: very dissatisfied (1) to very satisfied (4)</li> </ol>
HIV Medical Procedures Scale	Sum of the following procedures received in last six months (except as noted) <ol style="list-style-type: none"> <li>1) Physical examination</li> <li>2) Blood test</li> <li>3) Adherence support services</li> <li>4) Sexual risk screening</li> <li>5) Substance use screening</li> <li>6) Women's health services (female participants only)</li> <li>7) Hepatitis C screening (since last interview)</li> <li>8) Dental care</li> <li>9) CD4 test</li> </ol>
Continuity of Medical Care	Had at least one medical care visit in last six months AND kept all scheduled medical appointments in last six months

### *Data Analysis*

A hierarchical sequence of regression models was estimated to investigate the correlates of viral suppression. The baseline model estimated the joint effects of demographic characteristics on study outcomes. The second model added health-related behaviors and conditions, including housing situation. The third model added variables that measured the use of health and social services to address these behaviors and conditions. We included case management and medication adherence support among these services. The fourth model added characteristics of HIV medical care. A fifth model included, as a final correlate of viral suppression, self-reported medication adherence. The logistic regression models were estimated using random effects methodology that adjusts for the dependency among multiple observations contributed by the same individual. We also estimated viral load regression models separately for NYC and Tri-County. Results for the regional models were similar to those obtained by pooling data for the two regions and are not summarized in this report.

### **Results**

Based on the surveillance data, 77% of NYC participants and 78% of Tri-County participants had viral loads less than or equal to 200 at the time that interviews were conducted between 2010 and 2017. Table 2 presents results of a regression analysis using the outcome of viral suppression (as determined via surveillance data). The five numbered columns correspond to the five regression models described above. The coefficients reported in Table 2 are the logged-odds ratios of viral suppression for each independent variable, adjusted for the confounding effects of other independent variables. Positive coefficients indicate that the odds of viral suppression increase with higher values on the independent variables, whereas negative coefficients indicate lower odds of viral suppression. For categorical variables such as male gender, a positive coefficient indicates that the odds of viral suppression are higher for the category shown than for the reference (or excluded) category (in this case, female gender), and a negative value indicates a lower odds of viral suppression.

Consistent with the expected clinical pathway from use of ART to viral suppression, self-report of being completely adherent to ART was among one of the strongest correlates of viral suppression. Participants who reported that they were completely adherent to ART had an odds of viral suppression that was 3.71 (Adjusted odds ratio =  $e^{1.312}$ ) times higher than for other

participants. Several other variables were also associated with viral suppression, independent of their association with self-reported medication adherence. Among sociodemographic variables, older age at time of interview and MSM behavior were associated with viral suppression ( $p < 0.05$ ). African American participants had lower odds than non-Hispanic white participants of achieving viral suppression ( $p < 0.05$ ), though viral suppression was not significantly different between non-Hispanic white participants and other racial and ethnic groups. Current employment was also associated with viral suppression, but its association was diminished to non-significance after the successive inclusion of variables for health-related behaviors and conditions, health and social services, and ART adherence.

Among health-related behaviors and conditions, current drug use and unstable housing were negatively associated with viral suppression. Among health and social service interventions, nutritional counseling was positively associated with viral suppression. By contrast, medical case management was negatively associated with viral suppression.

Turning to medical care characteristics, participants accompanied to a medical care visit by an individual they identified as a patient navigator or a family member, friend or volunteer had lower odds of viral suppression than individuals who attended their medical care visits without accompaniment. Continuity of medical care was associated with higher odds of viral suppression.

**Table 2: Adjusted Log-Odds Ratios of Viral Suppression by Participant Factors, Combining NYC and Tri-County Participants (SE's in Parentheses)**

	(1)	(2)	(3)	(4)	(5)
<b>Demographic Variables</b>					
Tri-County	0.053 (0.127)	0.004 (0.127)	0.140 (0.135)	0.109 (0.137)	0.094 (0.140)
Age	0.028*** (0.005)	0.025*** (0.006)	0.022*** (0.006)	0.020*** (0.006)	0.020*** (0.006)
Male Gender	-0.180 (0.133)	-0.043 (0.134)	0.057 (0.137)	-0.005 (0.139)	-0.039 (0.143)
Men who have Sex with Men (MSM)	0.511** (0.171)	0.544** (0.178)	0.457* (0.178)	0.471** (0.179)	0.419* (0.183)
Education	0.000 (0.036)	-0.021 (0.035)	-0.041 (0.036)	-0.047 (0.036)	-0.043 (0.036)
<b>Race/Ethnicity:</b>					
Black	-0.407+ (0.222)	-0.470* (0.220)	-0.528* (0.225)	-0.523* (0.223)	-0.466* (0.225)
Latino	-0.126 (0.232)	-0.230 (0.229)	-0.388 (0.237)	-0.380 (0.236)	-0.360 (0.240)
Other	-0.223 (0.348)	-0.296 (0.343)	-0.385 (0.351)	-0.333 (0.358)	-0.202 (0.357)
Currently Working	0.310* (0.144)	0.266+ (0.146)	0.207 (0.151)	0.223+ (0.155)	0.180 (0.156)
<b>Health-Related Behaviors and Conditions</b>					
Problem Substance Use		-0.659*** (0.117)	-0.631*** (0.119)	-0.560*** (0.121)	-0.576*** (0.122)
Need for Mental Health Services		0.119 (0.106)	0.095 (0.106)	0.115 (0.108)	0.140 (0.112)
Unstable Housing		-0.277** (0.104)	-0.273** (0.106)	-0.232* (0.107)	-0.222* (0.111)
Food Insecurity		-0.215+ (0.127)	-0.180 (0.163)	-0.179 (0.130)	-0.192 (0.134)
Nutritional Counseling Need		0.227 (0.140)	0.209 (0.142)	0.178 (0.143)	0.185 (0.144)
<b>Health and Social Services</b>					
Housing Assistance			0.181 (0.129)	0.104 (0.141)	0.059 (0.144)
Food Services			-0.302 (0.189)	-0.295 (0.194)	-0.323 (0.197)
Nutritional Counseling			0.364*** (0.104)	0.394*** (0.106)	0.388*** (0.109)
Mental Health Services			0.112 (0.101)	0.150 (0.104)	0.126 (0.106)
Drug Treatment			-0.256+ (0.133)	-0.260+ (0.135)	-0.221 (0.145)
Medical Case Management (CM)			-0.146** (0.055)	-0.170** (0.055)	-0.176** (0.056)
Social Service CM			-0.038 (0.041)	-0.042 (0.035)	-0.038 (0.035)
Counseling CM			0.067 (0.077)	0.059 (0.067)	0.057 (0.069)
Adherence Services			0.109 (0.109)	0.165 (0.116)	0.131 (0.120)
<b>Medical Care Characteristics</b>					
Comprehensive Primary Care				-0.046 (0.111)	-0.052 (0.112)
Medical Provider Satisfaction Scale				0.051 (0.032)	0.037 (0.033)
Accompanied to Medical Care Visit by: Patient Navigator				-0.652+ (0.109)	-0.740* (0.120)

Other Paid Staff				(0.382)	(0.366)
				0.321	0.522
Family, Friend or Volunteer				(0.395)	(0.396)
				-0.374*	-0.319+
HIV Medical Procedures Scale				(0.166)	(0.172)
				-0.048	-0.070+
Continuity of Medical Care				(0.041)	(0.041)
				0.517***	0.541***
				(0.105)	0.108
<b>Medication Adherence</b>					
Self-Reported Completely Adherent to ART					1.312***
					(0.134)
Constant	0.001	0.361	0.831	0.334	-0.480
	(0.368)	(0.392)	(0.438)	(0.565)	(0.580)
+ p<0.10 * p<0.05, ** p<0.01, *** p<0.001					
Sample Size: 2,687 interviews for 1,378 individuals					
Reference category for Race/Ethnicity is Non-Hispanic white participants and for Accompanied to a Medical Care Visit, it is Unaccompanied.					
SE Standard Error					

### *Subgroup Variation in Viral Suppression.*

Table 3 displays estimated rates of viral suppression for subgroups defined by variables that were found to be statistically significant in the regression analysis, specifically Model 5 in Table 2. The first column displays the observed subgroup rates of viral suppression. Observed differences in viral suppression by medication adherence status were particularly pronounced. Eighty-one percent of those reporting complete adherence to their HIV medications were virally suppressed, as compared to 51% of those reporting less than complete adherence. Other variables with large subgroup variation included age, current drug use status, continuity of medical care, and housing status. Only 62% of cohort members younger than 30 were virally suppressed, compared to 73% of those older than 50. Other subgroups with relatively low rates of viral suppression included current drug users (66%), those who experienced a disruption in medical care (68%), and unstably housed individuals (71%).

However, observed rates of viral suppression may not be the best statistic for assessing subgroup differences because of correlations among the independent variables. For example, individuals with substance use problems are more likely than other individuals to experience unstable housing conditions. To disentangle the correlated effects of the independent variables, we estimate the probability of viral suppression from the results of the regression analysis, specifically Model 5 in Table 2. The adjusted rate of viral suppression corresponding to each subgroup reported in the second column of Table 3 is estimated as if the entire sample was a member of a particular subgroup while leaving unchanged the values of the other independent variables. Thus the adjusted viral suppression rate for problem substance users, 73%,

**Table 3: Rates of Subgroup Viral Suppression Before and After Adjustment for Confounding Effects of Other Variables.<sup>1</sup>**

	<b>Observed Viral Suppression</b>	<b>Adjusted Viral Suppression</b>
Age:		
18-29		62%
30-39		65%
40-49		69%
Older than 50 <sup>2</sup>		73%
MSM:		
Yes	78%	76%
No (both Males and Females)	76%	69%
Females	77%	71%
Ethnicity		
Black	75%	61%
Latino	79%	63%
White	83%	70%
Other	75%	66%
Problem Substance User		
Yes	66%	63%
No	81%	73%
Unstable Housing		
Yes	71%	68%
No	80%	72%
Region of Residence		
NYC	77%	70%
Tri-County	78%	72%
Nutritional Counseling		
Yes	81%	75%
No	75%	68%
Medical C.M.		
No	73%	72%
4 or more Activities	58%	69%

<sup>1</sup> Note: Table reports subgroups for variables that were statistically significant predictors of viral suppression in final regression model. Adjusted viral suppression proportions are estimated from Model 5 in Table 2. See text for details on the procedure for estimating predicted values. The unit of observation is the interview; consequently, unique individuals may be represented by as many as four interviews in the NYC cohort. Multiple observations on unique individuals are much less frequent for the repeated cross-sectional surveys conducted in Tri-County.

<sup>2</sup> Observed rates of viral suppression for these age groupings were not available.

Escort to Medical Visit		
None	77%	83%
Escort	56%	77%
P.N.	87%	75%
Volunteer	68%	88%
Continuity of Medical Care		
Yes	81%	73%
No	68%	63%
Completely Adherent		
Yes	81%	78%
No	51%	52%

is the viral suppression rate that equation 5 estimates as though the entire sample had substance use problems, but values on all other variables remain unchanged. Adjusted subgroup differences in viral suppression greater than 10% are limited to problem substance use, continuity in medical care, and medication adherence.

## Discussion

### *Overview*

Since 2010, a large majority of CHAIN participants, 77% in NYC and 78% in Tri-County, have been virally suppressed at the time of their interviews. This level of suppression is in line with recent U.S. (CDC 2018) and New York State estimates,<sup>1</sup> but below the 85% that New York State has set as a goal for its Ending the Epidemic Initiative (NYSDOH 2018). The aim of this paper was to identify participant factors associated with viral suppression.

### *Adherence and Viral Suppression*

As one would expect, self-reported adherence to a recommended ART regimen was the most prominent factor associated with suppressed viral load. Surveillance data indicated that, among CHAIN participants reporting complete adherence to ART, 81% were virally suppressed, as compared to only 51% who reported they were either not completely adherent to their prescribed ART regimens or not taking an ART regimen at time of interview.

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<sup>1</sup>AIDS Institute's 2018 Ending the Epidemic Progress Report estimates that 70% of NYC residents, and 64% of Mid-Hudson residents living with diagnosed HIV, had viral load <200 copies/ml at the end of December 2017.

*Demographic Factors Independently Associated with Viral Suppression*

This study is consistent with other studies that have found higher rates of viral suppression among older individuals (Doshi 2015). Table 2 suggests a possible connection through age-related differences in health-related behaviors and conditions and in service utilization. There is a consistent (if modest) reduction in the size of the age regression coefficients in Table 2 as variables for health-related behaviors and conditions, and then health and social services are added to the regression models. This pattern suggests that part of the positive association between age and viral suppression may be a consequence of more frequent practice of healthy behaviors, reduced exposure to unhealthy conditions, and greater engagement in health and social services among older members of the cohort. In particular, older participants are less likely than younger participants to report recent unstable housing conditions. The higher prevalence of correlates of viral suppression among older individuals may also be a consequence of life-long patterns of effective engagement in medical care and medication adherence that promote sustained viral suppression throughout the life course and thus improve the chances of survival into older age. It is also possible that these age differences are due to changes that occur later in life among those surviving to older age (Doshi 2015). Whether these age differences are related to healthy aging or life-long practices, we concur with the conclusion of Doshi et al. (2015, p. 123) that “[l]earning strategies and motivators used by older individuals to achieve high HIV care engagement and medication adherence could be valuable to younger persons.”

*Health-Related Behaviors and Conditions Associated with Viral Suppression*

This study found that current drug use and unstable housing are negatively associated with viral suppression. Indeed, the effects of these variables were not materially altered after controlling for self-reported medication adherence (compare coefficients in Models 4 and 5 in Table 2). Possible explanations may include their impact on the immune system or (at least for substance use) pharmacokinetics (i.e., ability to absorb ART medications). Current drug use (Edelman, Gordon, Tate et al. 2017; Jiang, Luo, Martin et al. 2018; Rib, Chang, Wevers et al. 2012) may impair the body’s ability to fight HIV infection even among individuals on ART. Unstable housing may be understood as a stressor that might impair health in general or immune functioning in particular or distract one from seeking health care or maintaining medication adherence (Galarraga, Rana, Rahman et al. 2018; Kidder et al. 2007; Rehm et al. 2017). Harm

reduction programs designed to improve adherent use of ART medication among active drug users (Nolan, Walley, Herren et al. 2017) and among homeless individuals (Hawks & Davis 2011) are certainly important components of efforts to end the HIV epidemic. Future research and evaluation studies should be directed at a better understanding of how “harm reduction” strategies that promote medication adherence complement drug treatment and housing assistance as inter-related strategies that contribute to a comprehensive plan to promote sustained viral suppression.

### *Service Interventions Independently associated with Viral Suppression*

The association between nutritional counseling and viral suppression may be the result of either selection or causal processes. On the one hand, individuals who seek out nutritional counseling may tend to be those who engage in a broader range of health-related behaviors that support viral suppression. On the other hand, nutritional counseling may directly promote dietary choices that contribute to viral suppression.

Differential selection may also explain the negative association between medical case management services use and viral suppression. For instance, Ryan White medical case management in NYC is directed at people who experience difficulty achieving and/or maintaining viral suppression. A similar “selection” interpretation may explain why viral suppression was lower among individuals accompanied to a medical care visit by a patient navigator, a family member, friend or volunteer. Individuals accompanied to a medical care visit may have been targeted for this service precisely because they were prone to disruption in care that might take the form of missed doctor’s appointments, lapses in filling medical prescriptions, and/or non-adherence to medication regimens—all of which increase the risk of unsuppressed viral load.

### *Medical Care Features Associated with Viral Suppression*

Among several characteristics of medical care, continuity of care was found to be the one most strongly associated with viral suppression. With longer patient contact comes increased provider knowledge about a patient’s overall health, health behaviors and living conditions, which may better inform tailoring of medical care to improve clinical outcomes. To look at this variable from the opposite perspective, one might note the adverse consequences that recent

disruption in care (within six months of interview) might have on monitoring disease progression and maintaining continuity in medication prescribing and adherence.

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