

Correlates of Self-Reported Viral Suppression Among HIV-Positive, Young, Black Men Who Have Sex With Men Participating in a Randomized Controlled Trial of An Internet-Based HIV Prevention Intervention

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Background: Young, black men who have sex with men are disproportionately impacted by the US HIV epidemic, and HIV-positive, young, black men who have sex with men face stark disparities in HIV clinical outcomes. **Methods:** We performed an observational analysis of the 199 HIV-positive black men aged 18 to 30 years followed up for 12 months in healthMpowerment, a randomized controlled trial of an Internet-based HIV prevention intervention, to identify time-varying correlates of self-reported viral suppression using relative risk (RR) regression.

Results: Retention at the 12-month visit was 84%. One hundred five (65%) of 162 participants reported being undetectable at baseline. At 3, 6, and 12 months, 83 (72%) of 115, 84 (82%) of 103, and 101 (86%) of 117 reported an undetectable viral load, respectively. In a multivariable model, participants who reported homelessness (RR, 0.85; 95% confidence interval [CI], 0.72–0.99), who had clinically significant depressive symptoms (RR, 0.88; 95% CI, 0.79–0.98), and who used methamphetamine or crack (RR, 0.61; 95% CI, 0.38–0.96) were less likely to report an undetectable viral load. Young men who engaged in condomless insertive anal intercourse were more likely to report viral suppression (RR, 1.14; 95% CI, 1.04–1.24).

Conclusion: HIV care for young, black men who have sex with men must be multidimensional to address medical needs in the context of mental health, substance use, and housing insecurity.

HIV-positive black men who have sex with men (MSM) face significant inequities in HIV care, morbidity, and mortality.¹ HIV viral load suppression is an important indicator not only of HIV care but also of the risk for secondary HIV transmission. A modeling study estimated that only 16% of US HIV-positive black MSM achieved an undetectable viral load.² There are no estimates of viral suppression specific to HIV-positive, young, black MSM (YBMSM); however, data from clinics serving HIV-positive youth aged 13 to 24 years (81% male, 72% black, 70% gay/bisexual) estimated that only 7% achieved viral suppression.³

Development of programs to create equity in HIV outcomes requires examination of the individual- and structural-level barriers

that YBMSM face in navigating HIV care. Therefore, we sought to determine the correlates of viral suppression among HIV-positive black MSM participating in a randomized controlled trial of healthMpowerment (HMP), an Internet-based HIV prevention intervention designed for YBMSM.^{4,5}

METHODS

Study Population

We conducted an observational analysis of HIV-positive men participating in HMP, a randomized controlled trial of an Internet-based intervention for HIV-positive and HIV-negative black MSM aged 18 to 30 years.^{4,5} healthMpowerment provided HIV and sexually transmitted infection (STI) prevention and care information, resources, personalized feedback, game-based elements, and a social networking platform to interact with other participants. The control was a Web site that provided basic information on HIV and STI. Although participants were told that the trial would last 3 months, they could access their respective Web sites for the entire 12-month follow-up period.

Participants were recruited from local community-based organizations, HIV and STI clinics, local college campuses, and venues frequented by YBMSM and through online ads posted on Craigslist, Facebook, Grindr, Jack'd, Adam4Adam, and black Gay Chat. Study participants were also offered incentives to invite peers to participate in the study.

Eligibility criteria were as follows: (1) age of 18 to 30 years, (2) being born biologically male, (3) self-identification as black or African American, (4) current residence in North Carolina, (5) current access to a mobile device with Internet access and texting capabilities, and (6) any one of the following in the past 6 months: (a) condomless anal sex with a male partner; (b) anal sex with more than 3 cisgender male or transgender female partners; (c) exchange of sex for money, gifts, shelter, or drugs; or (d) anal sex while under the influence of drugs or alcohol (i.e., 2 hours before or during sex). Participants were eligible if they reported either insertive or receptive anal sex.

All participants completed online surveys at baseline and at 3, 6, and 12 months. The study period spanned November 2013 to October 2016.

The study was approved by the University of North Carolina at Chapel Hill Institutional Review Board (No. 10-2179).

Outcome of Interest

The outcome of interest was an undetectable viral load (UVL). Baseline and follow-up surveys queried HIV-positive participants about whether their viral load was checked in the prior 3 months. If yes, a follow-up question asked if that viral load was undetectable. In a study assessing the accuracy of self-reported UVL,

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agreement between self-report and a clinic-recorded viral load of less than 50 copies/mL was 88%.⁶

Predictors of Interest

Study-Related Characteristics. We examined the relationship between self-reported viral suppression and group assignment, study follow-up time, and the total time spent on the intervention Web site during the 12-month study period calculated from Web site usage statistics.

Sociodemographic Characteristics. Survey items captured demographic information, including age, identification with other races or ethnicities, sexual identity, relationship status, educational attainment, employment status, homelessness, and involvement with the criminal justice system.

Psychosocial Variables. We used the Center for Epidemiologic Studies–Depression Scale (CES-D), a validated 20-item survey, to measure depressive symptoms in the prior 2 weeks (Cronbach $\alpha = 0.90$).⁷ The range of the scale is 0 to 60. A score of at least 16 indicates clinically significant depressive symptoms. The Generalized Anxiety Disorder 7-item scale (GAD-7) assessed participants' experience of anxiety symptoms in the prior 2 weeks (Cronbach $\alpha = 0.93$).⁸ The range of the scale is 0 to 21, with cutoffs of 5, 10, and 15 indicating mild, moderate, and severe anxiety, respectively. We used the Medical Outcomes Study Social Support Survey to assess perceived social support.⁹ We calculated subscales of emotional support (Cronbach $\alpha = 0.97$), tangible support (Cronbach $\alpha = 0.92$), affectionate (Cronbach $\alpha = 0.94$), and positive social interaction (Cronbach $\alpha = 0.96$) as well as the overall support index. Scores ranged from 0 to 100, with higher scores indicating greater perceived social support. The Lubben Social Network Scale captured participants' ease and frequency of contact with friend and familial networks (Cronbach $\alpha = 0.83$).¹⁰ The range of possible scores is 1 to 30, with lower scores indicating greater social isolation. A score of lower than 12 indicates social isolation. Finally, we queried participants about their experiences with discrimination due to their HIV status, sexual identity, and race. Each scale has a range of 0 to 10. We used the experiences with HIV discrimination (enacted stigma) subscale of an HIV stigma assessment developed by Steward and colleagues¹¹ (Cronbach $\alpha = 0.84$). We used the multiple discrimination scale to assess experiences of discrimination due to sexual orientation and race (Cronbach $\alpha = 0.88$ for both).¹²

Sexual Risk. We asked participants to enumerate their male anal sex partners by HIV status and sexual role over the past 3 months. Survey items captured whether participants exchanged condomless anal sex for money, drugs, shelter, or gifts.

Substance Use. Survey items assessed smoking status, use of alcohol, cocaine, inhalants (e.g., poppers, nitrous oxide, and glue), "club" drugs (e.g., ketamine, γ -hydroxybutyrate [GHB], and methylenedioxy-methamphetamine [MDMA]), erectile dysfunction medications (e.g., sildenafil [Viagra], vardenafil [Levitra], and tadalafil [Cialis]), crack, methamphetamine, and opiates in the past 3 months. A current smoker was defined as having smoked cigarettes in the last week. Alcohol use was classified as heavy (≥ 5 d/wk with ≥ 5 drinks per day) or less than heavy (including no use). We did not include a "no use" category, because only 7 participants reported not using alcohol throughout the entire study period. All other substance use was classified as any or none.

Statistical Analyses

Using generalized linear regression with a log link and binomial distribution, we estimated the relative risk (RR) as a measure of association between self-reported viral suppression and study and demographic characteristics, scores on psychosocial

health scales, sexual risk, and substance use.¹³ All predictors were modeled as time-varying covariates except for study characteristics and immutable demographic characteristics. A robust variance estimator accounted for repeated measures over time.

First, we examined univariable models for each predictor of interest within 3 domains: (1) study and demographic variables, (2) psychosocial variables, and (3) sexual risk and substance use variables. Scores on psychosocial indices were evaluated as continuous variables in the univariable models because most of the scales do not have standardized cutoffs. Thus, the interpretation of the RR is the change in the probability of reporting a UVL associated with a 1-unit change in the score on the psychosocial variable. Second, those predictors that were significant at the $P < 0.2$ level were included in a multivariable model examining predictors within each of the 3 domains. Finally, those predictors that were significant at the $P < 0.05$ level in the 3 multivariable, domain-specific models were included in a final, full multivariable model. The 3 domain-specific models and the final model were adjusted for study group. For the final multivariable model, we defined statistical significance at the $P < 0.05$ level. All analyses were conducted using STATA 14.2 (College Station, TX).

RESULTS

We enrolled 199 HIV-positive participants, of whom 174 (87%), 167 (84%), and 168 (84%) completed 3, 6, and 12-month online surveys, respectively (Table 1). Ninety-two (46%) were randomized to the control Web site and 107 (54%) were randomized to the HMP intervention. The median age was 24.5 years (interquartile range [IQR], 23–27 years). Thirty-four percent identified as multiracial or multiethnic. Sixty-eight percent identified as gay; 14% as bisexual; 15% as queer, transgender, or other; and 2% as straight or questioning. Sixty-one percent were single, 67% completed more than a high school education, and 60% were currently employed. Eighty percent had health insurance. One third of participants reported being homeless in the past 3 months, and 8% reported being arrested or incarcerated in the past 3 months.

Over the course of the 12-month study period, HIV-positive participants used their assigned Web site for a median of 11 minutes (IQR, 5–38.5 minutes; range, 1–1250 minutes) and a mean (SD) of 73 (190) minutes.

At baseline, 162 (81%) of 199 participants had a viral load measured in the prior 3 months, with 115 of (66%) 174, 103 (62%) of 167, and 118 (70%) of 168 reporting viral load measurements in the prior 3 months on the 3, 6, and 12-month follow-up surveys. One hundred five (65%) of 162 participants reported being undetectable at baseline. At 3, 6, and 12 months, 83 (72%) of 115, 84 (82%) of 103, and 101 (86%) of 117 reported a UVL, respectively. Overall, participants reported being undetectable on 373 (75%) of 497 online surveys.

Ten participants completed only the baseline survey and 5 (50%) reported a UVL. The 21 participants who completed one follow-up survey after baseline contributed 30 assessments and reported a UVL on 21 (70%) of those surveys. Of the 66 surveys contributed by the 35 participants who completed the 2 surveys after baseline, a UVL was reported on 45 (68%) of those assessments. Finally, 133 participants who completed all of the online surveys contributed 391 assessments, on which a UVL was reported at 302 (77%).

Univariable Models

Table 2 presents the proportion of online surveys (including baseline and follow-up surveys) in which participants report being

TABLE 1. Baseline Study and Demographic Characteristics, Psychosocial Health, and Sexual and Substance Use Behaviors of HIV-Positive YBMSM Participating in HMP, 2013 to 2016 (N = 199)

	Proportion of Participants, n (%), and/or Median (IQR)
Study-related characteristics	
Group	
Control	92 (46)
Intervention	107 (54)
Retention	
3 mo	174 (87)
6 mo	167 (84)
12 mo	168 (84)
Sociodemographic characteristics	
Age, y	24.5 (23–27)
Multiracial/multiethnic	65 (34)
Sexual identity	
Gay	136 (68)
Bisexual	28 (14)
Queer/transgender/other	30 (15)
Straight/questioning	5 (2)
Single	121 (61)
Completed more than high school education	134 (67)
Currently employed	119 (60)
Health insurance	160 (80)
Homeless, last 3 mo	66 (33)
Arrested or incarcerated, last 3 mo	16 (8)
Psychosocial indices	
CES-D, score ≥ 16 , median (IQR)	114 (58); 17 (10–26)
GAD-7, score ≥ 10 , median (IQR)	29 (15); 6 (2–11)
Lubben social network score, score < 12 , median (IQR)	80 (40); 13 (9–17)
Overall social support score	74 (50–95)
Emotional support subscore	75 (50–100)
Tangible support subscore	75 (44–94)
Positive social interaction support subscore	75 (50–100)
Affectionate support subscore	75 (50–100)
Experience with HIV discrimination score	1 (0–3)
Experience with sexual minority discrimination score	2 (0–4)
Experience with racism score	1 (0–4)
Sexual behavior	
Any condomless receptive anal intercourse	90 (45)
Nonconcordant condomless receptive anal intercourse*	31 (16)
Any condomless insertive anal intercourse	71 (36)
Nonconcordant condomless insertive anal intercourse	27 (14)
Use of alcohol or drugs before nonconcordant condomless anal intercourse	57 (29)
Substance use	
Cigarettes, past week	109 (55)
Heavy alcohol use, past 3 mo [†]	29 (15)
Cocaine use, past 3 mo	26 (13)
Inhalants (poppers, glue, nitrous oxide), past 3 mo	14 (7)
Erectile dysfunction medications, past 3 mo	7 (4)
Ketamine, GHB, MDMA, past 3 mo	14 (7)
Methamphetamine or crack use, past 3 mo	18 (9)
Opiates, including heroin, past 3 mo	11 (6)

*Nonconcordant is defined as anal intercourse with a man of negative or unknown HIV status.

[†]Heavy alcohol use is defined as alcohol use on 5 or more days per week with 5 or more drinks per day.

undetectable or not by study features and sociodemographic characteristics. The proportion of surveys in which participants reported a UVL increased over time. In addition, completing more than a high school education and current employment were associated with a greater probability of self-reported viral suppression. Identification as multiracial or multiethnic; identification as queer, transgender, or other; being single; and homelessness in the prior 3 months were associated with a greater risk of a detectable viral load.

Table 3 presents the median and IQR of scores on each of the psychosocial indices by study visit and self-report of a UVL.

Participants who reported greater depressive and anxiety symptoms and scored higher on scales measuring experiences of discrimination based on HIV status and sexual orientation were less likely to report a UVL. Conversely, higher levels of emotional support and lower levels of social isolation were associated with a greater probability of a UVL.

Study participants were more likely to report a UVL on online surveys in which they also reported condomless insertive anal intercourse (Table 4). Substance use before or during condomless anal sex with a partner of unknown or negative (nonconcordant) HIV status was associated with lower probability of a UVL. Study

TABLE 2. Self-Reported UVL and Study and Demographic Characteristics of HIV-Positive YBMSM Participating in HMP, 2013 to 2016

	Proportion of Surveys on Which Participants Do Not Report a UVL, n/N (%)	Proportion of Surveys on Which Participants Report a UVL, n/N (%)	Univariable RR (95% CI)	P
Study-related characteristics				
Group				
Control	64/243 (26)	179/243 (74)	REF	
Intervention	60/254 (24)	194/254 (76)	1.04 (0.91–1.18)	0.582
Web site usage				
≤120 min	111/432 (26)	321/432 (74)	REF	
>120 min	13/65 (20)	52/65 (80)	1.08 (0.93–1.24)	0.890
Survey time				
Baseline	57/162 (35)	105/162 (65)	REF	
3 mo	32/115 (28)	83/115 (72)	1.11 (0.97–1.23)	0.129
6 mo	19/103 (18)	84/115 (82)	1.26 (1.10–1.43)	0.001
12 mo	16/117 (14)	101/117 (86)	1.33 (1.18–1.51)	<0.001
Demographic characteristics				
Age, y				
18–24	52/206 (25)	154/206 (75)	REF	
25–35	72/291 (25)	221/291 (75)	1.00 (0.89–1.14)	0.915
Multiracial/multiethnic				
No	69/324 (21)	255/324 (79)	REF	
Yes	36/42 (44)	46/82 (56)	0.84 (0.72–0.98)	0.023
Sexual identity				
Gay	83/366 (23)	283/366 (77)	REF	
Bisexual	13/63 (21)	50/63 (79)	1.03 (0.89–1.18)	0.718
Queer/transgender/other	24/57 (42)	33/57 (58)	0.75 (0.58–0.97)	0.029
Straight/questioning	4/11 (36)	7/11 (64)	0.82 (0.54–1.25)	0.359
Relationship status				
In a relationship	34/198 (17)	164/198 (83)	REF	
Single	90/299 (30)	209/299 (70)	0.84 (0.75–0.95)	0.003
Highest level of education				
High school or less	48/151 (32)	103/151 (68)	REF	
More than high school	27/345 (22)	269/345 (78)	1.14 (0.97–1.34)	0.100
Currently employed				
No	57/175 (33)	118/175 (67)	REF	
Yes	67/322 (21)	255/322 (79)	1.17 (1.03–1.34)	0.019
Health insurance				
No	20/73 (27)	53/73 (73)	REF	
Yes	104/424 (24)	320/424 (76)	1.03 (0.89–1.21)	0.614
Homeless, last 3 mo				
No	72/371 (19)	299/371 (81)	REF	
Yes	52/124 (42)	72/124 (58)	0.72 (0.60–0.86)	<0.001
Arrested or incarcerated, last 3 mo				
No	111/456 (25)	341/456 (75)	REF	
Yes	13/45 (29)	32/45 (71)	0.94 (0.76–1.16)	0.585

Bold indicates $P < 0.2$ and inclusion into multivariable model.

REF indicates reference group.

participants were less likely to report a UVL on online assessments in which they reported smoking cigarettes, using methamphetamine or crack, or using opiates.

Multivariable Models: Domain-Specific Models

In the multivariable model of study and sociodemographic characteristics (Table 5), participants were more likely to report a UVL over study time. Compared with those participants who reported being housed, those who were homeless in the past 3 months were 36% less likely to report a UVL.

Compared with participants who had a score of lower than 16 on CES-D, those who had a score of at least 16 were 13% less likely to report a UVL in the model of psychosocial indices. On the 242 surveys in which participants scored at least 16 on CES-D, 78 (32%) reported a detectable viral load.

In contrast, participants reported a detectable viral load on 45 (18%) of 251 surveys in which they scored lower than 16 on CES-D.

In the model of sexual and substance use behaviors, participants who reported condomless insertive anal intercourse were 10% more likely to have a UVL compared with those who did not report this sexual practice. Those who smoked were 13% less likely to a UVL, whereas those who used methamphetamine or crack were 44% less likely a UVL.

Multivariable models: Full Model

In the final, full multivariable model, each successive study visit was associated with a 2% increase in report of viral suppression (Table 5). Participants who reported being homeless in the prior 3 months were 15% less likely to report a UVL compared

TABLE 3. Self-Reported UVL and Psychosocial Health Indices of HIV-Positive YBMSM Participating in HMP, 2013 to 2016

	Median (IQR) on Surveys in Which Participants Do Not Report a UVL	Median (IQR) on Surveys in Which Participants Report a UVL	Univariable RR* (95% CI)	P
CES-D score			0.99 (0.98–1.0)	0.001
Baseline	17.5 (11.5–25.5)	16 (9–23)		
3 mo	22 (11–29)	12 (8–21)		
6 mo	25 (12–36)	13 (8–23)		
12 mo	26.5 (12.5–30)	15 (7–24)		
GAD-7 score			0.99 (0.98–1.0)	0.058
Baseline	6 (1–10)	6 (2–11)		
3 mo	7.5 (1–14)	3 (0–9)		
6 mo	6 (0–11)	4 (0–9)		
12 mo	10 (2–13)	5 (0–9)		
Lubben social isolation score			1.01 (1.00–1.02)	0.069
Baseline	13 (10–16)	14 (9–18)		
3 mo	10.5 (7–15)	14 (10–18)		
6 mo	12 (7–17)	13 (10–18)		
12 mo	9.5 (6–12)	15 (10–18)		
Overall social support scale			1.00 (0.99–1.00)	0.201
Baseline	75 (51–95)	74 (50–99)		
3 mo	64 (48–82)	70 (50–96)		
6 mo	50 (50–74)	71 (50–95)		
12 mo	59 (47–75)	75 (50–100)		
Emotional support			1.00 (1.00–1.01)	0.120
Baseline	75 (50–97)	75 (50–100)		
3 mo	59 (46–94)	75 (50–100)		
6 mo	50 (47–75)	75 (50–100)		
12 mo	61 (50–90)	75 (50–100)		
Tangible support			1.00 (0.99–1.00)	0.236
Baseline	76 (44–94)	75 (44–100)		
3 mo	62.5 (41–78)	56 (44–100)		
6 mo	50 (44–75)	69 (50–94)		
12 mo	62.5 (50–81)	75 (50–100)		
Positive social interaction support			1.00 (0.99–1.00)	0.704
Baseline	71 (50–100)	75 (50–100)		
3 mo	67 (42–100)	75 (50–100)		
6 mo	50 (42–75)	71 (50–100)		
12 mo	67 (50–92)	67 (50–100)		
Affectionate support			1.00 (0.99–1.00)	0.490
Baseline	75 (50–100)	75 (46–100)		
3 mo	58 (42–100)	75 (42–100)		
6 mo	50 (50–75)	67 (46–100)		
12 mo	54 (33–87.5)	67 (50–100)		
Experienced HIV discrimination score			0.97 (0.95–1.00)	0.052
Baseline	1 (0–3)	1 (0–2)		
3 mo	1 (0–3.5)	0 (0–3)		
6 mo	2 (1–5)	0 (0–2)		
12 mo	1 (0–4.5)	0 (0–2)		
Experienced sexual minority discrimination score			0.97 (0.95–0.99)	0.026
Baseline	2 (0–4.5)	1 (0–4)		
3 mo	2 (0–5)	0 (0–4)		
6 mo	4 (0–7)	0 (0–3)		
12 mo	0 (0–2)	0 (0–2)		
Experienced racial discrimination score			0.99 (0.96–1.01)	0.221
Baseline	0 (0–4)	1 (0–3)		
3 mo	2 (0–4)	0 (0–3)		
6 mo	0 (0–5)	0 (0–2)		
12 mo	0 (0–2.5)	0 (0–3)		

Bold indicates $P < 0.2$ and inclusion into multivariable model.

*Interpretation of RR is the change in probability of reporting an UVL associated with a 1-unit change in the score of the psychosocial index.

with those who were housed. Compared with a score of lower than 16, a score of at least 16 on CES-D was associated with a 12% lower probability of a self-reported UVL. Compared with those

who did not report condomless insertive anal intercourse, those who did were 14% more likely to report a UVL. Those who used methamphetamine or crack in the prior 3 months were 39%

TABLE 4. Self-Reported UVL and Sexual Risk and Substance Use of HIV-Positive YBMSM Participating in HMP, 2013 to 2016

	Proportion of Surveys on Which Participants Do Not Report a UVL, n/N (%)	Proportion of Surveys on Which Participants Report a UVL, n/N (%)	Univariable RR (95% CI)	P
Sexual risk				
Condomless receptive anal intercourse with a partner of any HIV status				
No	78/314 (25)	236/314 (75)	REF	
Yes	46/183 (25)	137/183 (75)	1.0 (0.89–1.11)	0.942
Nonconcordant condomless receptive anal intercourse*				
No	106/436 (24)	330/436 (76)	REF	
Yes	18/58 (31)	40/58 (69)	0.91 (0.75–1.11)	0.362
Condomless insertive anal intercourse with a partner of any HIV status				
No	97/361 (27)	264/361 (73)	REF	
Yes	27/137 (20)	109/136 (80)	1.10 (0.99–1.23)	0.086
Nonconcordant condomless insertive anal intercourse				
No	116/452 (26)	336/452 (74)	REF	
Yes	8/43 (19)	35/43 (81)	1.09 (0.93–1.28)	0.261
Use of alcohol or drugs before nonconcordant condomless anal intercourse				
No	94/403 (23)	309/403 (77)	REF	
Yes	30/94 (32)	64/94 (68)	0.89 (0.75–1.04)	0.152
Substance use				
Cigarette smoking, past week				
No	48/262 (18)	214/262 (82)	REF	
Yes	76/235 (32)	159/235 (68)	0.83 (0.73–0.93)	0.002
Alcohol use, past 3 mo				
None, or less than heavy	107/435 (25)	328/435 (75)	REF	
Heavy†	17/62 (27)	45/62 (73)	0.96 (0.80–1.15)	0.679
Cocaine use, past 3 mo				
No	24/91 (26)	67/91 (74)	REF	
Yes	15/48 (31)	33/48 (69)	0.93 (0.74–1.18)	0.568
Inhalants (poppers, glue, nitrous oxide), past 3 mo				
No	24/92 (26)	68/92 (74)	REF	
Yes	9/21 (43)	12/21 (57)	0.77 (0.51–1.17)	0.227
Erectile dysfunction medications, past 3 mo				
No	25/97 (26)	72/97 (74)	REF	
Yes	4/11 (36)	7/11 (64)	0.86 (0.54–1.35)	0.508
Ketamine, GHB, MDMA, past 3 mo				
No	26/95 (27)	69/95 (73)	REF	
Yes	8/20 (40)	12/20 (60)	0.83 (0.57–1.20)	0.322
Methamphetamine or crack use, past 3 mo				
No	105/465 (23)	360/465 (77)	REF	
Yes	19/32 (59)	13/32 (41)	0.52 (0.32–0.85)	0.008
Opiates, including heroin, past 3 mo				
No	115/480 (24)	365/480 (76)	REF	
Yes	9/17 (53)	8/17 (47)	0.62 (0.36–1.06)	0.082

Bold indicates $P < 0.2$ and inclusion into multivariable model.

*Nonconcordant is defined as anal intercourse with a man of negative or unknown HIV status.

†Heavy alcohol use is defined as alcohol use on 5 or more days per week with 5 or more drinks per day.

REF indicates reference group.

less likely to report a UVL compared with those who did not use these drugs. Smoking was not statistically significant in the final model.

DISCUSSION

In contrast to prior reports,^{2,3} rates of viral suppression in the HMP sample were robust. Fifty percent (102/199) of HIV-positive participants were recruited from HIV clinics and community organizations serving HIV-positive individuals, which may explain the high rates of viral suppression in our population. Our findings are not inconsistent, however, with trends in viral suppression among

black MSM sampled in the Medical Monitoring Project, where the prevalence of viral suppression increased from 65% to 73% from 2009 to 2013.¹⁴

We observed an increase in viral suppression over time. Of the total 497 online assessments, there were 257 (52%) at which we could assess a change in viral suppression, meaning that a participant reported 2 or more viral load measurements during the 12-month study period. Participants reported a detectable viral load after being undetectable at 13 (5%) of 257 assessments, no change in viral suppression at 209 (81%) of 257 assessments (29/209 [14%] remained detectable, whereas 180/209 [86%] remained suppressed),

TABLE 5. Domain-Specific and Final Multivariable Models Assessing Correlates of an UVL Among HIV-Positive YBMSM Participating in HMP, 2013–2015

	Multivariable RR	95% CI	P
Model 1: Study and sociodemographic characteristics			
Survey time, continuous	1.06	1.01–1.10	0.028
Multiracial/multiethnic	0.90	0.79–1.01	0.144
Queer/transgender/other	0.67	0.44–1.02	0.064
Currently single	0.90	0.80–1.02	0.143
Completed high school or more	1.15	0.92–1.45	0.308
Currently employed	1.04	0.88–1.22	0.772
Homeless, past 3 mo	0.64	0.48–0.84	0.002
Model 2: Psychosocial health indices			
CES-D score (≥16 vs <16)	0.85	0.76–0.96	0.020
GAD-7 score (≥10 vs <10)	0.91	0.73–1.13	0.410
Lubben social network scale (<12 vs ≥12)	0.99	0.89–1.11	0.924
Emotional support, continuous *	1.0	0.99–1.01	0.733
Experienced HIV discrimination, continuous *	1.0	0.97–1.03	0.991
Experienced sexual minority discrimination, continuous *	0.99	0.96–1.01	0.274
Model 3: Sexual and substance use behaviors			
Condomless insertive anal intercourse, past 3 mo	1.10	1.00–1.22	0.032
Sex or drugs during condomless sex with a discordant partner, past 3 mo	0.99	0.87–1.12	0.845
Smoking, past week	0.87	0.78–0.97	0.014
Methamphetamine or crack use, past 3 mo	0.56	0.33–0.92	0.023
Opiate use, including heroin, past 3 mo	0.89	0.56–1.40	0.603
Model 4: Full multivariable model			
Survey time, continuous	1.02	1.01–1.03	<0.001
Homelessness, past 3 mo	0.85	0.72–0.99	0.041
CES-D score (≥16 vs <16)	0.88	0.79–0.98	0.025
Cigarette smoking, past week	0.92	0.83–1.03	0.143
Condomless insertive anal intercourse, past 3 mo	1.14	1.04–1.24	0.005
Methamphetamine or crack use, past 3 mo	0.61	0.38–0.96	0.034

All models are adjusted for intervention group. Bold indicates $P < 0.05$.

*Interpretation of RR is the change in probability of reporting an UVL associated with a 1-unit change in the score of the psychosocial index.

and a change from a detectable viral load to an undetectable one at 35 (14%) of 257 assessments. The latter change from a detectable viral load to an undetectable one was stable over time, reported by 17 (17%) of 97, 10 (12%) of 82, and 8 (11%) of 78 participants at 3, 6, and 12 months, respectively (P value for trend = 0.101). In addition, participants' report of health insurance (75%–80%), receipt of HIV care (87%–95%), and antiretroviral medication use (82%–86%) were high and stable over the study period. In the setting of this stable care measures and transition to a UVL over time, retention of participants who were more likely to report a UVL may provide an alternative explanation to the finding of an increase in viral suppression over time.

In addition to limitations to external generalizability of our observed rates of viral suppression due to our recruitment sources, self-report of viral suppression may have led to misclassification of our outcome of interest. Although the accuracy of self-report of a UVL has been estimated to be 88% among MSM, this estimate may be affected by age, housing status, education, employment status, and depressive symptoms.⁶

At baseline, one third of participants reported being homeless in the prior 3 months. Participants who reported homelessness were significantly less likely to report a UVL. Prior studies have shown that lack of stable housing is a significant barrier to HIV care, antiretroviral uptake and adherence, and sustained viral suppression; moreover, providing housing to homeless or unstably housed individuals with HIV improves HIV clinical outcomes.¹⁵ In comparison to white youth, black youth are less likely to identify with the stigmatizing term “homeless” and, thus, not use, or be reached by, services relevant to homeless youth.¹⁶ Participants of HMP who reported homelessness were significantly more likely

to score at least 16 on CES-D (RR, 1.71; 95% confidence interval [CI], 1.44–2.01) and to use methamphetamine or crack (RR, 3.07; 95% CI, 1.64–5.74). Thus, structural interventions to ameliorate housing challenges must also address concurrent mental illness and substance use.

At baseline, 58% of the HIV-positive participants scored at least 16 on CES-D. Scientists have demonstrated that depression is highly prevalent among black MSM¹⁷ and that depression is associated with a longer time to viral suppression and a shorter time to virologic failure among HIV-positive individuals initiating antiretroviral therapy.¹⁸ Black Americans experience significant disparities in access to mental health care,¹⁹ disparities that are likely more acute among HIV-positive YBMSM.

Participants reporting condomless insertive anal intercourse were more likely to have a UVL. In a study of young MSM attending adolescent HIV clinics, black MSM with detectable viral loads were less likely to report condomless anal intercourse compared with MSM of other races/ethnicities with detectable viral loads.²⁰ HIV-positive HMP participants who reported nonconcordant condomless insertive anal intercourse were also more likely to be undetectable, but this association was not statistically significant. Thus, HIV-positive YBMSM may use their knowledge of HIV transmission risk to guide their sexual practices, engaging in condomless insertive anal sex only when undetectable and, thus, not infectious.

Less than 10% of the HIV-positive HMP participants reported methamphetamine or crack use at baseline, but use of psychostimulants was the strongest predictor of a detectable viral load. Stimulant use among HIV-positive people has been associated with poorer adherence to antiretroviral therapy, virologic failure, more rapid HIV progression, and sexual behaviors that risk

secondary HIV transmission.²¹ In the HMP population, greater than 50% reported smoking at baseline. Smokers were more likely to be homeless (RR, 2.04; 95% CI, 1.47–2.81), score at least 16 on CES-D (RR, 1.33; 95% CI, 1.10–1.60), and use methamphetamine or crack (RR, 2.94; 95% CI, 1.37–6.32) compared with nonsmokers. Thus, smoking seems to be a marker of psychosocial instability that interferes with successful viral suppression.²²

Attention to intersectional identities in HIV care may improve clinical outcomes among YBMSM. Identification with multiple races and ethnicities and identification as queer, transgender, or other were significantly associated with a detectable viral load in univariable models. In our sample, participants identifying as queer, transgender, or other were more likely to meet CES-D criteria for depression (RR, 1.36; 95% CI, 1.17–1.60) and report homelessness (RR, 1.43; 95% CI, 1.05–1.94). Participants identifying as multiracial or multiethnic were more likely to be depressed (RR, 1.43; 95% CI, 1.16–1.76), use stimulants (RR, 3.33; 95% CI, 1.72–6.44), and report homelessness (RR, 1.53; 95% CI, 1.11–2.13).

Additional limitations deserve discussion. Sixty-two percent to 81% of participants reported having a viral load measurement in the prior 3 months over the study period. Missing viral load data could be explained by the more recent every-6-month schedule of routine HIV care visits; however, there are likely other factors in our data that may also explain this missingness. Employed participants were more likely to report a viral load in the prior 3 months (RR, 1.12; 95% CI, 1.02–1.23), whereas homelessness participants (RR, 0.86; 95% CI, 0.77–0.96) and those experiencing greater social isolation (RR, 0.89; 95% CI, 0.81–0.97) were less likely to report a viral load in the prior 3 months. Those with a score of at least 16 on CES-D (RR, 0.93; 95% CI, 0.81–1.01) and those who reported methamphetamine or crack use (RR, 0.87; 95% CI, 0.87–1.04) were somewhat less likely to have had a viral load in the prior 3 months. The factors associated with missing viral load are also associated with our outcome of interest, report of a UVL. If those missing viral load data were actually detectable, the missing viral load information in our data would likely bias our RRs toward the null. We should also note that the strength of the associations we observed in our data may be particular to HIV-positive, YBMSM with high levels of care engagement and may not be generalizable to less engaged populations. It is possible that the strength of association between the predictors of having a detectable viral load that we observed (e.g., homelessness, depression, and stimulant use) may be larger in a more vulnerable population. In addition, a larger sample size may have allowed us to observe associations between report of a UVL and other variables in our data that did not reach statistical significance.

In a sample of HIV-positive YBMSM with a high rate of viral suppression, homelessness, depression, and stimulant use were independent predictors of a detectable viral load. Future investigation should be aimed at further elucidating pathways to homelessness for YBMSM and developing services that are accessible and acceptable to homeless black youth. The significant impact of crack and methamphetamine use on viral suppression, the high prevalence of depression among YBMSM, and the co-occurrence of these factors with homelessness call for universal integration of HIV care, mental health services, and substance use treatment. In addition, HIV services should continue to foster, and capitalize on, young black men's integration of HIV knowledge and sexual practices to reduce HIV transmission risk. Thus, the health behaviors of HIV-positive YBMSM must be addressed in the context of their intersecting social, economic, political, and sexual landscapes.^{23–25} Only interventions that address poverty, racism, HIV stigma, and

homophobia at the governmental, community, and familial levels will ameliorate challenges to individual-level physical and emotional health to produce a durable state of health equity for YBMSM living with HIV.

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