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Age and racial disparities in substance use and self-reported viral suppression among men who have sex with men with HIV

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Abstract

HIV disproportionately affects men who have sex with men (MSM). Substance use is common among people living with HIV and may affect antiretroviral therapy adherence. Nevertheless, research examining the association between substance use and viral suppression is lacking. The aims of this study were to determine the association between substance use and self-reported viral suppression, and by age and race among MSM living with HIV. Data were obtained from 309 HIV-positive MSM. Logistic regression was used to determine the association between substance use and self-reported viral suppression at baseline, and by age and race. Approximately 67% of participants reported they were virally suppressed. After adjusting for sociodemographics, every increase in substance use score was associated with a 7% decrease in the odds of reporting viral suppression (odds ratio [OR]: 0.93; 95% confidence interval [CI]: 0.89–0.98; $p = 0.003$). The negative association between substance use and self-reported viral suppression remained statistically significant among MSM aged 25–34 years (OR = 0.89; 95% CI: 0.79–1.00; $p = 0.041$) and statistically significant for Black MSM (OR = 0.92; 95% CI: 0.86–0.98; $p = 0.009$). Intervention programs for MSM living with HIV aimed at improving viral suppression should address substance use and consider the differences by age and race.

Keywords

Substance use; race; age; HIV; viral suppression

Introduction

HIV/AIDS continues to be a major public health challenge for men who have sex with men (MSM). In 2015, MSM accounted for 82% of the new diagnoses among men aged 13 and older and 67% of all new diagnoses in the US.[1] Even though it is estimated that MSM account for 4% of men in the US, their HIV incidence rate is at least 44 times that of other

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Access to research materials

Underlying research materials related to the paper can be accessed by contacting Dr Julianne Serovich (jserovich@usf.edu).

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men.[2] These statistics show that MSM continue to be disproportionately impacted by the epidemic.

Age and racial/ethnic differences exist in HIV rates among MSM. For example, from 2008 to 2014, the number of new cases declined among White MSM, stabilized among Black MSM, but increased among Latino MSM.[2] However, it is estimated that 50% of Black MSM, 25% of Latino MSM, and 9% of White MSM will be diagnosed with HIV at some point during their lifetime.[3] Younger MSM continue to account for a higher proportion of new cases compared to older men. In fact, in 2014, approximately two-thirds of the incident HIV cases among MSM were among those ages 13–34 years, while 16% were 35–44, and 17% were 45 and older.[2]

In spite of the age and racial/ethnic differences, substance use remains a major challenge among MSM. Compared to the general population, MSM are more likely to use alcohol and drugs and have higher rates of substance use.[4] Research has shown that the prevalence of alcohol use and drug use disorders is estimated at 13 and 27%, respectively,[5] among people living with HIV.[6] The prevalence of alcohol use among MSM aged 50 and older living with HIV has been estimated at 53%, and substance use has ranged from 0.4% (ecstasy, GHB, LSD/PCP) to 32% (painkillers) prevalence depending on the type of substance.[6] Substance use has also been shown to be associated with HIV risk behavior, such as unprotected anal intercourse, specifically among MSM living with HIV.[7–9]

For populations living with HIV, achieving suppression of HIV viral load is a desired outcome as this signifies that the level of HIV in the blood is very low[10] and risk of HIV transmission is greatly reduced. Modest reductions in viral load are shown to have immunological benefits with an increase in CD4 cell count.[11] However, substance use may prevent attainment of viral suppression via behavioral (lower antiretroviral therapy [ART] adherence) or immunological (biological) pathways.[12] Findings related to the association between drug use and ART adherence have been mixed based on the type of substance. Arnsten et al.[13] found that cocaine use demonstrated the strongest association with poor ART adherence, and hence, inability to maintain viral suppression. However, no statistically significant associations were found for alcohol use and active heroin use.[13] Biologically, drugs such as alcohol, tobacco, and methamphetamine have been linked to lower responses to ART,[14] which may be due to drugs impacting cytochrome P450 (CYP) pathways and increased toxicity in the body.[15]

Age and racial differences have been associated with substance use[5,16] and the attainment of viral suppression.[17] Older age has been related with greater alcohol use.[5] White populations were more likely to report problematic drinking and except for marijuana, racial/ethnic minority patients were more likely to report other drug use (cocaine, crack heroin, methamphetamine, or painkillers).[16] Castel et al.[17] found a 4% increase in the odds of achieving viral suppression with every five-year increase in age. Research has shown that Black populations have lower odds of achieving[18] and sustaining viral suppression.[17] An additional study of neighborhoods in New York City found that Black HIV-positive populations living in the most impoverished neighborhoods in the city had the lowest proportion of viral suppression compared to other racial and/ or socioeconomic groups. In

contrast, White populations in the least impoverished neighborhoods had the highest proportion of viral suppression.[19]

Additional sociodemographic differences have been found in substance use and viral suppression. An inverse relationship between education, monthly income, and employment has been associated with substance use, such that less education, income, and employment are linked to greater substance use.[20] Lower socioeconomic status (lower income, lack of employment, lower levels of educational attainment) has been linked to poorer response to ART,[21] which may lead to a lower likelihood of achieving viral suppression. Time since diagnosis has also been associated with viral suppression, albeit these findings were with women.[22]

At present, research is lacking in examining the association between substance use and viral suppression among MSM living with HIV. Therefore, the primary aim of this study was to determine if substance use was associated with self-reported viral suppression. Due to age and racial/ethnic disparities in substance use and achievement of viral suppression, the secondary aim was to examine the association between substance use and viral suppression by age and race. Age was categorized into four groups so as to examine the results for youth (ages 18–24),[23] younger middle-aged (ages 25–34), middle-aged (ages 35–49), and older MSM (ages 50+years).[24] Race comparisons were made between Black and White MSM. We hypothesized that an increase in substance use would be associated with lower odds of self-reported viral suppression and that differences by age and race would exist. The findings from this study will help to determine important foci for interventions aimed at improving viral suppression among MSM living with HIV and specific target populations that would benefit greatly from these interventions.

Materials and methods

Data source and study population

Data were obtained from MSM living with HIV at the baseline assessment of a longitudinal disclosure intervention study. The intervention aimed to help MSM decide whether to disclose their HIV serostatus to their casual sex partners. The intervention took place from December 2009 to 2014. To be eligible, men had to have been diagnosed with HIV, be at least 18 years old, be sexually active in the past three months with at least one male partner, and indicate an interest in learning more about HIV disclosure. Men were recruited from two metropolitan statistical areas (MSAs) in the Midwestern and Southeastern US. All participants provided written informed consent and could receive up to $260 for attending all seven sessions over the course of one year.

Participants were recruited via local and state AIDS service organizations (ASOs), HIV-related venues and forums in the MSAs, local eating and drinking establishments in the MSAs, and advertisements in local daily newspapers. Caseworkers at the ASOs were informed about the study and information was also distributed to potential participants through direct mailings and newsletters. The study was also advertised on the ASOs' websites. Data were collected using audio-computer-assisted self-interviewing. The study

was approved by the Ohio State University and the University of South Florida Institutional Review Boards.

Measures

Substance use was measured at baseline using the Substance Abuse and Mental Illness Symptoms Screener (SAMISS).[25] Seven items inquired about the participants: (1) frequency of having a drink containing alcohol, (2) number of drinks they have on a typical day when drinking, (3) frequency of having four or more drinks on one occasion, (4) frequency of nonprescription drug use in the past year to get high to change the way they felt, (5) frequency of use of drugs prescribed to them or someone else in the past year to get high or change the way they felt, (6) frequency of drinking or using drugs more than they meant to in the last year, and (7) frequency of feeling that they wanted or needed to cut down on their drinking or drug use in the last year and had not been able to. A Likert-type response scale ranging from *1 or 2 (1)* to *10 or more (4)* was used for item 2. All other items were scored using a Likert-type response scale ranging from *Never (1)* to *4 or more times a week (5).* The seven items were summed to obtain a score for substance use. For the current study, the standardized Cronbach's alpha was 0.77. To determine the percentage of MSM in the study population who had a substance use disorder, the Whetten criteria[25] were used. Any positive score on the SAMISS indicates substance use. However, the Whetten criteria suggest that participants have a substance use disorder or that their substance use is problematic if any of the following criteria are met from the SAMISS: (1) the sum of responses for items 1–3 is ≥5, *(2)* the sum of the responses for items 4 and 5 is ≥3, or *(3)* the sum of responses for items 6 and 7 is ≥1.[25]

Viral suppression was operationalized by the question 'What is your most recent viral load?' Participants were able to indicate their viral load level or if it was undetectable. These responses were dichotomized to 'virally suppressed' ('Undetectable' or <200 copies/ml) versus 'not virally suppressed' (responses ≥200 copies/ml).

Confounders of the association between substance use and viral suppression were selected based on review of the literature. Sociodemographic characteristics that were assessed included age in years (as a continuous variable and as a categorical variable [18–24, 25–34, 35–49 versus 50 and older]), race (Black versus White), education (less than high school, high school, some college versus college graduate/graduate school), monthly income ($0-$500, $501-$1000, versus $1001+), employment (yes versus no), time since diagnosis (as a continuous variable and as a categorical variable [≤1 year, >1 to ≤5 years, >5 to ≤10 years versus >10 years]), and location (Southeastern versus Midwestern MSA). Age and time since HIV diagnosis were treated as both continuous and categorical variables. The continuous variable yields results that are not influenced by loss of power. The categorical variable gives more practical results that can be used in intervention and prevention programs targeting specific age groups or based on an interval of time when someone has been diagnosed with HIV. The youth and older age categories (18–24, 50 and older) were selected based on the CDC categorization of youths and older adults with respect to HIV/AIDS epidemiologic data.[23,24] The middle two categories were selected so as to separate younger and middle-aged MSM (25–34, 35–49). The categories for time since diagnosis

were used in prior research.[26] Finally, because data were obtained from two MSAs, location was added as a confounder to all analyses.

Analytic approach

Data were collected from 338 MSM. Participants were excluded from the current study if they were missing data on self-reported viral suppression ($n = 5$) using a complete case analysis approach in the handling of missing data in the study. No participants were missing data on all substance use variables. In addition, participants were excluded if they did not identify as Black or White ($n = 24$), in order to make a clean comparison between Black and White participants. Therefore, the resultant sample size was 309.

The distribution of sociodemographic characteristics by self-reported viral suppression and by substance use was examined. P-values based on the Chi square statistic and the F statistic from the Welch's test were used to determine statistically significant differences among categorical variables and continuous variables, respectively (see Table 1). Age and time since diagnosis were used as continuous and categorical variables in the assessment of the distribution of sociodemographics. Pearson correlation coefficients were obtained measuring the linear relationship between age and time since diagnosis (as continuous variables), and viral suppression and substance use. The related p-values were based on |r|. The distribution of age categories among Black and White participants was also examined (see Table 2).

Hierarchical logistic regression models were used to determine the association between substance use and self-reported viral suppression (see Table 3): Model 1: an unadjusted model with substance use as the main risk factor; Model 2: adjusting for confounders (education, income, employment, time since diagnosis, and location); and Model 3: adjusting for confounders and effect measure modifiers (age and race). Age and time since diagnosis were operationalized as categorical variables in these analyses.

Based on the findings of Model 3, the association between substance use and viral suppression was further examined (or stratified) by age and race using six different models (see Table 4): For MSM: (1) 18–24, (2) 25–34, (3) 35–49, (4) 50 and older, (5) Black, and (ó) White. Analyses by age controlled for confounders and race, and analyses by race controlled for confounders and age. Age and time since diagnosis were also used as continuous variables as covariates in the models for the logistic regression analyses. All analyses were performed in SAS version 9.4 (SAS Institute, Cary, NC).

Results

The distribution of sociodemographic characteristics overall, by self-reported viral suppression, and by substance use are presented in Table 1. Overall, 67% ($n = 208$) of the study participants reported viral suppression. There were statistically significant differences in self-reported viral suppression by age, race, income, time since diagnosis, location, and substance use. Viral suppression was positively associated with being older (age 35 and above), White race, higher incomes (greater than $1000 a month), longer time since diagnosis (more than one year), living in the Southeastern MSA, and no substance use.

Approximately 72% (n = 224) of participants reported substance use based on the Whetten[25] criteria. There were statistically significant differences in mean substance use scores by age, income, time since diagnosis, and location. Higher substance use was positively associated with being younger (age 49 and below), lower incomes ($0 to $500 per month), shorter time since diagnosis (less than one year), and living in the Midwestern MSA.

The distribution of age categories among Black and White participants in the study sample is presented in Table 2. For example, approximately 11% of Black participants and 4% of White participants were 18–24 years old, while 28% of Black and 33% of White participants were 50 years and older (p = 0.020).

The hierarchical logistic regression results are presented in Table 3. The crude model (Model 1) showed that substance use was associated with a 9% decrease in the odds of reporting viral suppression (OR: 0.91; 95% CI: 0.88–0.95; p = <0.001). Model 2 showed that after adjusting for confounders (education, income, employment, time since diagnosis, and location), substance use was associated with a 6% lower odds (OR: 0.91; 95% CI: 0.88–0.97; p < 0.001) of reporting viral suppression. Model 3 illustrated that this association remained significant after additionally adjusting for effect measure modifiers (age and race). In addition, in Model 3, age and race were significantly related to viral suppression.

The stratified results of assessing the association between substance use and viral suppression by age and race, adjusting for confounders are presented in Table 4. The overall model indicated that after adjusting for education, income, employment, time since diagnosis, location, age, and race, every increase in substance use score was associated with a 7% decrease in the likelihood of reporting viral suppression (adjusted OR: 0.93; 95% CI: 0.89–0.98; p = 0.003). Examining disparities by age, among men aged 25–34, every increase in substance use score was associated with an 11% decrease in the odds of reporting viral suppression (OR: 0.89; 95% CI: 0.79–1.00; p = 0.041). There were no statistically significant associations between substance use and self-reported viral suppression among men of other ages (i.e. 18–24, 35–49, and 50 and older). Examining disparities by race, among Black MSM, every increase in substance use score was associated with an 8% decrease in the odds of reporting viral suppression (OR = 0.92; 95% CI: 0.86–0.98; p = 0.009). There were no statistically significant associations between substance use and self-reported viral suppression for White MSM.

Discussion

The main finding of the study was that substance use was negatively associated with self-reported viral suppression. This association remained statistically significant for MSM aged 25–34 and for Black MSM. These findings supported the hypotheses that as substance use increased, self-reported viral suppression would decrease, and that differences by age and race would exist.

Viral suppression is a crucial outcome for populations living with HIV and reduction in HIV transmission risk. However, studies examining the direct link between substance use and viral suppression are lacking in the literature. Instead, a majority of studies examining the

association between substance use and HIV treatment outcomes tend to focus more on adherence to ART.[13,27–30] Research has shown that substance use[29] including active cocaine use,[13,30] marijuana use,[30] amphetamine use,[30] sedative use,[30] and alcohol use[28,30] was associated with lower adherence to ART. As ART adherence is a major factor in achieving viral suppression, these studies indirectly support our findings showing a negative association between substance use and viral suppression.

Examining disparities by age in the current study showed that the negative association between substance use and viral suppression remained statistically significant for MSM aged 25–34 but this was not seen for men of other ages. MSM aged 25–34 are in a period of their lives where they may be new to the work force and/or just graduated college, with potentially limited access to health care. This is also a period of newfound independence and new life stressors, and where substance use may be high. Indeed, in the current study, MSM in this age category had the highest mean score for substance use. Men who report higher substance use may be more susceptible to not reporting viral suppression due to additional stressors, such as financial hardship, lack of support, relationship difficulties, and domestic problems.[31] These stressors and the inability to cope may also disrupt their adherence to ART[32] and hence their viral suppression, compared to men in other age groups. Prior research has shown that younger MSM living with HIV tend to have lower levels of HIV care compared to older MSM,[33] and research has shown a positive association between age and viral suppression where older MSM have a higher likelihood of being virally suppressed.[17] Raimondo et al.[34] also found that being less than 55 years old was a risk factor for not achieving viral suppression.

The current findings indicate that Black MSM may be more susceptible to not achieving viral suppression due to substance use compared to White MSM. Prior research has been mixed showing racial differences and a lack thereof in substance use.[16,35] For example, Skalski et al.[16] found racial differences in problematic drinking but found no racial differences in problematic drug use among an HIV clinic population, and Mereish and Bradford[35] found no racial differences in overall substance use. However, in the current study population, there were no statistically significant differences by race in substance use. Studies have also shown that Black populations are less likely to obtain viral suppression compared to other racial groups.[17,19] Indeed, another potential pathway to explain the association between substance use and viral suppression is via a biological or immunological mechanism. The interaction of drugs in the body can lead to a decreased response to ART medication.[15] There is a specific pathway that plays a significant role in the metabolism of ART and substances, the CYP pathway. Racial differences have been found in CYP mechanisms, albeit among other chronic illnesses.[36]

The findings from the current study should be interpreted with some limitations in mind. The current study used self-reported viral suppression as the outcome. It is possible that participants may under- or overreport their viral load. Variables such as when participants last saw an HIV care provider and measures assessing engagement in care were not asked of all participants. In addition, substance use/abuse treatment was not assessed in the study. These variables also tend to vary by age and race/ethnicity and may have affected the association between substance use and viral suppression. Based on the way substance use

data were collected in the current study, it was not possible to determine the specific types of substances used, which can have important implications for the design and implementation of substance use interventions geared toward improving viral suppression. The sample size in each age group may have contributed to the inability to find associations. For example, youth were categorized using ages 18–24 based on the CDC's definition of youth and HIV. However, they made up only 6% of the sample.

Nevertheless, the study has several strengths. Substance use was operationalized as a continuous variable, which allows for examination of associations without the loss of power that comes with categorizing variables. We had a relatively large sample size ($N = 309$) and participants had a wide age range (ages 18–68). The analyses also adjusted for sociodemographic characteristics, which could have also altered the effect between substance use and viral suppression.

The study's findings suggest that substance use treatment components should be included in intervention programs geared toward improving viral suppression among MSM living with HIV, especially MSM aged 25–34, and Black MSM. Specifically, among MSM ages 25–34, interventions aimed toward this age group could address challenges, which may be specific to this age group, such as access to health care and the use of substances as a coping mechanism. It is important to address substance use among this age group, which may help to increase the odds of viral suppression. As substance use was the same among Black and White MSM, yet there was a statistically significant association with viral suppression among Black and not White MSM, substance use among Black MSM may increase susceptibility to viraemia whether behaviorally (e.g. lack of ART adherence) or biologically. Therefore, more studies are needed to examine these behavioral and/or biological pathways between substance use and viral suppression to determine if behavioral, biological, or combination (both behavioral and biological) interventions will be needed to eliminate this racial disparity.

Future studies should also examine the associations between specific types of substances used and viral suppression. These studies may help to determine even more specific target populations for intervention programs based on the substances used. Validation studies may also examine the validity of self-reported viral suppression compared to actual viral load measurements. As the global target for UNAIDS (90–90–90)[37] suggests that by 2020, 90% of people receiving ART will have viral suppression, findings from the current study underscore the need for objective measures of HIV treatment outcomes such as viral suppression and determining if similar results are found. Future research may also include qualitative research to delve deeper into potential reasons for the seemingly higher susceptibility of MSM aged 25–34 and Black MSM to poorer viral suppression associated with substance use. These findings may also help to identify specific focal points to aid in effectively designing and implementing interventions for these groups. Future studies could also examine the biological pathways between substance use and viral suppression, and aim to determine if there are immunological differences in these pathways by age and race.

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Table 1.

Distribution of sociodemographic characteristics overall and by self-reported viral suppression and substance use.

	N (%)	Virally Suppressed n = 208 N (%)	Not virally suppressed n = 101 N (%)	P-value[a]	Substance use (Mean, SD)	P-value[a]
Age in years (Mean, SD)	42.3, 11.0	45.3, 10.2	38.1, 10.9	<0.001	−0.238[b]	<0.001[c]
18–24	21 (6.8)	7 (3.4)	14 (13.9)	<0.001	14.0 (6.9)	<0.001
25–34	56 (18.1)	29 (13.9)	27 (26.7)		16.7 (6.2)	
35–49	137 (44.3)	94 (45.2)	43 (42.6)		14.0 (5.5)	
≥50	95 (30.7)	78 (37.5)	17 (16.8)		12.1 (5.0)	
Race				<0.001		0.724
Black	132 (42.7)	73 (35.1)	59 (58.4)		14.0 (6.3)	
White	177 (57.3)	135 (64.9)	42 (41.6)		13.8 (5.3)	
Ethnicity				0.966		0.779
Hispanic	16 (5.6)	5 (5.7)	11 (5.6)		13.6 (4.5)	
Not Hispanic	270 (94.4)	187 (94.0)	83 (94.4		14.0 (5.9)	
Education				0.165		0.094
Less than high school	33 (10.7)	21 (11.9)	12 (10.1)		14.6 (5.4)	
High school	73 (23.6)	4 (22.1)	27 (26.7)		14.6 (7.1)	
Some college	130 (42.1)	84 (40.4)	46 (45.5)		14.0 (5.6)	
College graduate/Graduate school	73 (23.6)	57 (27.4)	16 (15.8)		12.6 (4.6)	
Income				0.028		0.027
$0-$500	90 (29.1)	52 (25.0)	38 (37.6)		15.3 (6.4)	
$501-$1000	88 (28.5)	58 (27.9)	30 (29.7)		13.7 (5.7)	
$1001 +	131 (42.4)	98 (47.1)	33 (32.7)		13.1 (5.2)	
Employment				0.782		0.840
Employed	95 (30.7)	65 (31.3)	30 (29.7)		13.8 (5.7)	
Unemployed	214 (69.3)	143 (68.8)	71 (70.3)		13.9 (5.8)	
Time since diagnosis (years) (Mean, SD)	10.9, 8.2	12.5, 7.7	8.7, 8.6	<0.001	−0.148[b]	0.010[c]
≤1 year	36 (11.7)	8 (3.9)	28 (27.7)	<0.001	16.9 (6.0)	0.014
>1 to <5 years	61 (19.7)	40 (19.2)	21 (20.8)		14.0 (5.9)	
>5 to <10 years	52 (16.8)	40 (19.2)	12 (11.9)		13.8 (5.3)	
> 10 years	160 (51.8)	120 (57.7)	40 (39.6)		13.2 (5.6)	

	N (%)	Virally Suppressed n = 208 N (%)	Not virally suppressed n = 101 N (%)	P-value[a]	Substance use (Mean, SD)	P-value[a]
Location				<0.001		0.002
Southeastern MSA	159 (51.5)	121 (58.2)	38 (37.6)		12.9 (5.6)	
Midwestern MSA	150 (48.5)	87 (41.8)	63 (62.4)		14.9 (5.8)	
Substance use (Whetten) (Mean, SD)	13.9 (5.8)	12.9 (5.1)	15.9 (6.5)	<0.001	–	–
Yes	224 (72.5)	140 (67.3)	84 (83.2)	0.003		
No	85 (27.5)	68 (32.7)	17 (16.8)			

MSA: metropolitan statistical area.

[a]P-values are based on Chi square statistic for categorical variables and F statistic from the Welch's test for continuous variables.

[b]Pearson correlation coefficients.

[c]P-value based on |r|.

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Table 2.

The distribution of age categories and race in the study sample.

Age (years)	Black N = l32 N (%)	White N = l77 N (%)	Total N = 309
18–24	l4 (l0.6)	7 (4.0)	2l (6.8)
25–34	30 (22.7)	26 (14.7)	56 (18.1)
35–49	5l (38.6)	86 (48.6)	l37 (44.3)
50+	37 (28.0)	58 (32.8)	95 (30.7)

Table 3.

Crude and adjusted logistic regression models showing associations between substance use, sociodemographic characteristics, and viral suppression.

	Model 1[a] OR (95% CI)	p-value	Model 2[b] OR (95% CI)	p-value	Model 3[c] aOR (95% CI)	p-value
Substance use	0.91 (0.88–0.95)	<0.001	0.94 (0.89–0.98)	0.008	0.94 (0.89–0.98)	0.008
Education						
Less than high school	–	–	0.78 (0.27–2.22)	0.643	1.14 (0.38–3.41)	0.810
High school	–	–	0.58 (0.25–1.33)	0.199	0.77 (0.32–1.87)	0.569
Some college	–	–	0.54 (0.26-1.11)	0.094	0.66 (0.31–1.42)	0.291
College graduate/Graduate school	–	–	1.00	–	1.00	–
Income						
$0-$500	–	–	0.68 (0.33–1.43)	0.313	1.04 (0.46–2.35)	0.919
$501-$1000	–	–	0.70 (0.35–1.43)	0.331	0.87 (0.41–1.84)	0.711
$1001 +	–	–	1.00	–	1.00	–
Employment						
Employed	–	–	1.00	–	1.00	–
Unemployed	–	–	0.79 (0.40–1.54)	0.488	0.69 (0.34–1.41)	0.314
Time since diagnosis						
≤1 year	–	–	0.12 (0.05–0.30)	<0.001	0.16 (0.06–0.45)	<0.001
>1 to ≤5 years	–	–	0.73 (0.37–1.45)	0.369	1.02 (0.47–2.19)	0.962
>5 to ≤10 years	–	–	l.l2 (0.52–2.43)	0.768	1.46 (0.63–3.40)	0.381
>10 years	–	–	1.00	–	1.00	–
Location						
Southeastern MSA	–	–	1.78 (1.03–3.06)	0.039	1.49 (0.85–2.62)	0.161
Midwestern MSA	–	–	1.00	–	1.00	–
Age (years)						
18–24	–	–	–	–	0.22 (0.06–0.89)	0.033
25–34	–	–	–	–	0.38 (0.14–0.99)	0.047
35–49	–	–	–	–	0.48 (0.24–0.99)	0.046
≥50	–	–	–	–	1.00	–
Race						
Black	–	–	–	–	0.44 (0.25–0.79)	0.006

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	Model 1[a] OR (95% CI)	p-value	Model 2[b] OR (95% CI)	p-value	Model 3[c] aOR (95% CI)	p-value
White	–	–	–	–	1.00	–

MSA: metropolitan statistical area.

[a]Model 1: Substance use.

[b]Model 2: Substance use and confounders (education, income, employment, time since diagnosis, and location).

[c]Model 3: Substance use, confounders, and effect measure modifiers (age and race).

Table 4.

Association between substance use and self-reported viral suppression overall, by age group (in years), and by race.

	OR	95% CI	P-value	Adjusted OR[a]	Adjusted 95% CI[a]	P-value
Overall	0.91	0.88–0.95	<0.001	0.93	0.89–0.98	0.003
18–24	0.91	0.77–1.07	0.264	0.88	0.68–1.14	0.737
25–34	0.88	0.79–0.97	0.013	0.89	0.79-1.00[b]	0.041
35–49	0.94	0.88–1.00	0.061	0.94	0.87–1.00	0.064
50+	0.95	0.86–1.05	0.320	0.95	0.86–1.06	0.358
Black	0.90	0.85–0.96	0.001	0.92	0.86–0.98	0.009
White	0.93	0.87–0.99	0.017	0.96	0.89–1.02	0.191

[a]Adjusted odds ratio (OR) and confidence interval (CI). Overall model adjusted for education, income, employment, time since diagnosis, age (continuous), location, and race. Analyses by age controlled for education, income, employment, time since diagnosis, age (continuous), location, and race. Analyses by race controlled for education, income, employment, time since diagnosis (continuous), location, and age (continuous).

[b]0.793–0.995.