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A Longitudinal Analysis of Treatment Optimism and HIV Acquisition and Transmission Risk Behaviors Among Black Men Who Have Sex with Men in HPTN 061

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Abstract

Little is known about HIV treatment optimism and risk behaviors among Black men who have sex with men (BMSM). Using longitudinal data from BMSM in the HPTN 061 study, we examined participants' self-reported comfort with having condomless sex due to optimistic beliefs regarding HIV treatment. We assessed correlates of treatment optimism and its association with subsequent risk behaviors for HIV acquisition or transmission using multivariable logistic regression with generalized estimating equations. Independent correlates of treatment optimism included age ≥35 years, annual household income <$20,000, depressive symptoms, high HIV conspiracy beliefs, problematic alcohol use, and previous HIV diagnosis. Treatment optimism was independently associated with subsequent condomless anal sex with a male partner of serodiscordant/unknown HIV status among HIV-infected men, but this association was not statistically significant among HIV-uninfected men. HIV providers should engage men in counseling conversations to assess and minimize willingness to have condomless sex that is rooted in optimistic treatment beliefs without knowledge of viral suppression.

Keywords

HIV; treatment optimism; Black men who have sex with men; condom use; sexual risk behaviors

INTRODUCTION

Racial disparities in HIV incidence among men who have sex with men (MSM) remain a major public health problem in the United States (US), such that Black MSM (BMSM) continue to experience a disproportionately high burden of new HIV infections (1). The Centers for Disease Control and Prevention (CDC) recently reported an alarming estimate that 1 in 2 BMSM will be diagnosed with HIV in their lifetime compared with 1 in 4 Hispanic/Latino MSM and 1 in 11 White MSM (2). Of all MSM in the US, Black men accounted for the largest number of estimated new HIV infections in 2014: 38% were among Black men, 26% were among Hispanic/Latino men, and 31% were among White men (3). Although epidemiologic research to explain this disparity has increasingly pointed to partner-level factors, assortative mixing, and structural factors as key drivers of HIV risk, continued investigation of individual factors such as beliefs and attitudes that are proximal causes of risk behaviors remains an important approach to improving our understanding of HIV risk among BMSM (4, 5).

Over the last two decades, as antiretroviral therapy has transformed HIV infection into a chronic disease, one focus of HIV prevention research has evaluated optimistic beliefs related to the availability and efficacy of antiretroviral therapy and their association with sexual risk behaviors (6-8). HIV treatment optimism has been broadly defined as favorable perceptions regarding the availability or use of antiretroviral therapy, and has traditionally been comprised of two distinct components – a belief that HIV is a less serious health threat post-infection due to the availability of antiretroviral therapy (known as 'reduced-severity optimism') and a belief in reduced susceptibility to HIV due to the suppressive effect of antiretroviral therapy on the viral load of infected sexual partners (known as 'reduced-susceptibility optimism') (9-11). While optimism regarding the use of antiretroviral

medications reflects a growing and encouraging understanding that HIV is no longer a death sentence, there is also evidence that it may lead to increased sexual risk behaviors. Previous studies of diverse populations including MSM populations in the US have found that reduced-severity and reduced-susceptibility treatment optimism were associated with HIV risk behaviors including condomless anal sex (CAS), though studies have been largely cross-sectional and therefore unable to establish a causal link (6, 12-18).

In the current era of treatment as prevention and pre-exposure prophylaxis (PrEP), there has also been concern regarding risk compensation such as decreased condom use due to optimistic perceptions of reduced infectiousness or infectivity conferred by biomedical HIV interventions (6, 19). Although recent trials have found no instances of HIV transmission when HIV-infected persons were virologically suppressed for at least six months (20, 21), serodiscordant CAS remains a key risk factor for HIV transmission because many HIV-infected persons do not achieve viral suppression. One study estimated that only 21% of all BMSM in the US who were diagnosed with HIV had achieved viral suppression (22). Moreover, serodiscordant sexual partners may neglect to discuss viral load (of the infected partner) prior to having CAS. One study found that only 38% of HIV-infected MSM had considered their viral load in their decision to engage in CAS with a partner who was known or thought to be HIV-uninfected (23). Even when a discussion about viral load occurs between serodiscordant sexual partners, HIV-infected MSM may inaccurately report whether they are virologically suppressed. In a recent study, 36% of HIV-infected MSM who had a detectable viral load based on laboratory testing had reported during study procedures that their viral load was undetectable (24). Another study found that 92% of HIV-infected MSM reported that they were virologically suppressed at their last clinic visit, yet only 62% were actually virologically suppressed based on blood tests (25). Adherence to a once-daily pill regimen for PrEP can also eliminate the risk of HIV infection associated with CAS (26), but available data suggest that uptake of PrEP is relatively low among BMSM and that inadequate adherence is expected to prevent approximately half of BMSM with a PrEP prescription from achieving protection against HIV (27-30). For these reasons, in this paper we consider CAS with a serodiscordant partner to be a behavioral risk factor for HIV acquisition and transmission, though successful viral suppression and/or adherence to PrEP would effectively eliminate the risk associated with CAS between serodiscordant partners.

BMSM represent the US subpopulation with the highest HIV incidence, yet BMSM have been underrepresented in the research literature on treatment optimism and sexual behaviors (15). Two prior studies found that Black and Hispanic/Latino MSM were more likely to have treatment-related optimistic beliefs than White MSM (12, 31). However, only one study investigating treatment optimism was conducted among a sample comprised exclusively of BMSM, and the sample was limited to 174 men living with HIV (15). In that cross-sectional study, the belief that HIV is less transmissible to others now that treatment is available was associated with self-reported CAS with casual partners who were HIV-negative or unknown status. Another study based on data collected from MSM in the National HIV Behavioral Surveillance System (NHBS) in Dallas, Texas, found that Black men who indicated a willingness “to take a chance of getting infected or infecting someone else now that combination drug treatments are available” were more likely to regard themselves “as someone who practices bareback sex” (i.e., condomless sex), and this independent

association was not present among Hispanic/Latino or White men in analyses stratified by race/ethnicity (32).

Given limited research on treatment optimism and risk behaviors among BMSM in the US, we used longitudinal data from the HIV Prevention Trials Network (HPTN) 061 study to investigate treatment optimism (specifically, reduced-severity optimism) among a large prospective cohort of BMSM in six US cities. The aims of the present analysis were to determine the prevalence of this type of treatment optimism at each of three study visits (baseline, 6 months, and 12 months); to identify demographic, psychosocial, and behavioral correlates of treatment optimism; and to assess the association between treatment optimism and subsequent self-reported CAS with a male partner of serodiscordant or unknown HIV status. Our central hypothesis was that treatment optimism due to low perceived severity of HIV infection would be associated with CAS in the next six months with at least one male partner of HIV-positive or unknown status (among HIV-uninfected men) or with at least one male partner of HIV-negative or unknown status (among HIV-infected men). Our impetus for this analysis was to explore the importance of addressing individual perceptions of biomedical interventions as part of HIV prevention strategies targeted to populations most severely impacted by the HIV epidemic. Since there are gaps in PrEP coverage and viral suppression among HIV-uninfected and HIV-infected BMSM, respectively, understanding HIV treatment optimism and how it influences subsequent sexual risk behaviors can inform more nuanced HIV prevention messaging strategies for BMSM, such as those that would aim to prevent risk behaviors (in the absence of adherence to PrEP and/or without knowledge of viral suppression) while also recognizing that optimism regarding the efficacy of antiretroviral therapy for HIV prevention and treatment is warranted and rooted in scientific evidence.

METHODS

Study Sample

The methodology of the HPTN 061 study has been previously described in detail (33, 34). In brief, HPTN 061 was a study of BMSM to determine the feasibility and acceptability of a multifaceted HIV prevention intervention in six US cities: Atlanta, Boston, Los Angeles, New York City, San Francisco, and Washington, DC. Between July 2009 and October 2010, prior to US Federal Drug Administration (FDA) approval in 2012 of the use of Truvada as PrEP, BMSM were recruited directly from the community or as sexual network partners referred by index participants, who were identified as those who might be part of high-risk networks. Community recruitment methods included direct field-based outreach, engagement of key informants and community groups, advertising through various print and online media, and the use of chat room outreach and social networking sites. Eligibility criteria included self-identification as a man or being male at birth; self-identification as Black, African American, Caribbean Black, or multiethnic Black; and at least one self-reported instance of CAS with a man in the past six months. Institutional review boards at the participating institutions approved the study.

Study Procedures

Study procedures were conducted at the baseline enrollment visit and at two subsequent follow-up visits that occurred 6 and 12 months post-enrollment, as previously described (33, 34). Participants provided demographic information at the enrollment visit during an interviewer-administered questionnaire and completed, at each visit, a behavioral assessment using audio computer-assisted self-interview (ACASI) technology. Following the ACASI, participants received HIV and sexually transmitted infection (STI) prevention risk-reduction counseling and testing, and referral for care if needed. Participants were offered the opportunity to work with a Peer Health Navigator to identify and refer for service needs such as substance use and mental health needs. Aside from demographic characteristics and HIV status, all variables utilized in this analysis were measured using the ACASI and encompassed individual, social, and structural factors.

Measures

Demographic characteristics included age, city, education, and annual household income. At baseline, participants were classified as HIV-uninfected, newly diagnosed, or previously diagnosed based on confirmed HIV status at enrollment and whether they already knew they were HIV-infected. For participants with low or undetectable HIV viral loads who did not report a prior HIV diagnosis, enrollment samples were tested for the presence of antiretroviral drugs after the end of the study; men whose samples contained antiretroviral drugs indicative of antiretroviral therapy were considered to have a previous HIV diagnosis.

Treatment optimism due to low perceived severity of HIV was measured at each visit with two items in the ACASI questionnaire that asked participants to report their comfort with having condomless sex due to optimistic beliefs regarding HIV treatment: “I feel comfortable having unprotected sex because treatments for HIV will continue to improve” and “I feel comfortable having unprotected sex because HIV can be easily managed now.” Both items were measured on a 5-point Likert scale from “disagree” to “agree.” Participants were classified as endorsing reduced-severity treatment optimism (termed ‘treatment optimism’) if they agreed or somewhat agreed with at least one of these items, which is similar to a method previously used to dichotomize a scaled score for treatment optimism (31).

Based on previous research, we created a composite variable (separately for HIV-uninfected and HIV-infected participants, based on confirmed HIV status from retrospective quality assurance testing at the HPTN Network Laboratory) representing CAS with at least one male partner of serodiscordant (i.e., different HIV status) or unknown HIV status, as reported by participants based on a series of questions about their sexual partners in the last six months (35). Separate questions in the ACASI assessed the most recent male anal sex partner, the most recent male primary sex partner with whom he had anal sex (if different than the most recent anal sex partner), and any other male anal sex partners in the last six months. For each reported partner, follow-up questions collected information on the partner’s HIV status and whether there was at least one instance when a condom was not used during anal sex in the last six months. For participants who were confirmed HIV-uninfected based on study testing at enrollment, this variable was defined as CAS with at

least one male partner of positive or unknown HIV status (i.e., HIV acquisition risk behavior). For participants who were confirmed HIV-infected based on study testing at enrollment, this variable was defined as CAS with at least one male partner of negative or unknown HIV status (i.e., HIV transmission risk behavior). Although one's actual risk of HIV infection depends on various factors, we defined this outcome variable as described above in order to signify sexual behavior associated with highest risk for potential HIV acquisition and transmission. While the perceived serostatus of one's sexual partners may not accurately reflect their actual serostatus, this definition was appropriate because this analysis was focused on risk behaviors as reported by the participant rather than risk of actual seroconversion, which would also depend on other factors such as sexual network characteristics.

Symptoms of depression were measured using the Center for Epidemiology Studies Depression Scale (CES-D), a 20-item, 4-point Likert scale from "less than 1 day (rarely/ none of the time)" to "5-7 days (most of the time)" (α=0.88). Items that measured the frequency of depressive symptoms in the last week included "I was bothered by things that don't usually bother me" and "I felt sad." Based on the summarized score (possible range 0-60), a score ≥16 was indicative of depressive symptoms (≤36).

Social support was measured with six items such as "How often is there someone available to whom you can count on to listen to when you need to talk?" with responses on a 5-point Likert scale from "none of the time" to "all the time" (α=0.94). Using the summarized score (possible range 6-30), participants were categorized as having low social support (≤13), medium social support (14-21), or high social support (≥22) (37).

Internalized homophobia was measured using a 7-item, 5-point Likert scale from "disagree strongly" to "agree strongly" (α=0.91). Items included "In the past 90 days, I have tried to stop being attracted to men" and "I wish I weren't attracted to men." Based on the summarized score (possible range 7-35), participants were categorized as having low (≤16), medium (17-26), or high internalized homophobia (≥27) (38).

Perceived sexual discrimination and racism were measured using a 5-point scale with 25 and 28 items, respectively. Response options ranged from "doesn't bother me at all" to "bothers me extremely," indicating the extent to which participants were bothered by experiences attributed to their sexual identity (α=0.96) or race (α=0.95). Items included "Being ignored, overlooked, or not given service" and "Being treated rudely or disrespectfully." Participants also had the option to indicate that an experience had never happened to them. Based on the summarized scores for perceived sexual discrimination and racism (possible range 0-125 and 0-140, respectively), perceived sexual discrimination and racism were classified as never happened/low (≤42 and ≤47, respectively), medium (43-84 and 48-94, respectively), or high (≥85 and ≥95, respectively) (39).

Internalized HIV stigma was measured with five items such as "Society looks down on people who have HIV" with responses on a 5-point scale from "strongly disagree" to "strongly agree" (α=0.75). Based on the summarized score (possible range 5-25),

participants were categorized as having low (<16) or high (≥16) internalized HIV stigma (40).

HIV conspiracy beliefs were measured using a 9-item, 5-point Likert scale with responses from “strongly disagree” to “strongly agree” (α=0.92). Items included “HIV is a man-made virus” and “The medicine used to treat HIV causes people to get AIDS.” Based on the total score (possible range -18 to +18), conspiracy beliefs were classified as low (≤-6), medium (-5 to +6), or high (≥+7) (41).

Intimate partner violence was defined as a composite variable representing whether men reported at least one of four experiences with an intimate male partner in their lifetime: emotional abuse, physical abuse, being stalked, and being pressured or forced into doing something sexually (42).

Problematic alcohol use was defined as a score >8 on the Alcohol Use Disorders Identification Test (AUDIT), a 10-item questionnaire scored on a point system from 0 to 40 (43). Stimulant use was defined as the reported use of smoked and/or powder cocaine or methamphetamine in the last six months. Participants also reported whether they had used injection drugs in the last six months (34).

Statistical Analysis

Baseline descriptive statistics (frequencies and percentages) were calculated for each variable, stratified by baseline HIV status as defined above. Differences in variable distributions by HIV status were assessed using Chi-square tests. Longitudinal changes in the prevalence of treatment optimism among participants within each baseline HIV status category were assessed between enrollment and month 12 using McNemar’s test. We used multivariable logistic regression with generalized estimating equations (GEE), assuming an autoregressive correlation matrix, to assess correlates of treatment optimism (using data collected at each visit). Study city and demographic, psychosocial, and behavioral covariates that were associated with treatment optimism with $p<0.10$ in univariable models were considered for inclusion in the multivariable model, and were eliminated using a manual stepwise method until $p<0.05$ for each covariate remaining in the model. Multivariable logistic regression with GEE was also used to assess the association between treatment optimism and subsequent CAS with at least one male partner of serodiscordant or unknown status (separately for confirmed HIV-uninfected and HIV-infected participants). In this analysis, values for treatment optimism and all previously defined covariates at baseline and month 6 were used to model the likelihood of reporting CAS with a male partner of serodiscordant or unknown status at month 6 and month 12, respectively (CAS was reported for the prior 6 months, since the previous visit). Baseline CAS with at least one male partner of serodiscordant or unknown status, as reported at the enrollment visit for the previous six months, was adjusted for in this analysis. Treatment optimism, study city, and all covariates that were associated with the outcome variable with $p<0.10$ in univariable models were also included in the multivariable models (to ensure adjustment of confounding factors). For the purpose of regression modeling, missing data for covariates were multiply imputed using 10 imputed data sets among participants who provided responses for treatment optimism items (44); however, no missing data were imputed for treatment optimism or CAS. The use of

multiple imputation prevented a substantial reduction in the analytic sample size in multivariable analyses due to missing values of covariates and maximized the validity of estimated odds ratios (ORs) and adjusted odds ratios (aORs) (45). P-values <0.05 were considered statistically significant, and all analyses were conducted using SAS, Version 9.3 (Cary, NC).

RESULTS

Demographic, Psychosocial, and Behavioral Characteristics

Baseline characteristics of HPTN 061 participants are presented in Table I. Of 1,515 BMSM with a non-missing HIV status, 20% were 18-24 years old, 19% were 25-34 years old, and 61% were ≥35 years old (median age 40; IQR 27-47; range 18-68). Sixty percent of participants had an annual household income <$20,000, while 29% had an income between $20,000-$49,999 and 11% had an income ≥$50,000. Among HIV-uninfected participants, 51% reported CAS with at least one male partner of positive or unknown HIV serostatus in the six months prior to enrollment. Among HIV-infected participants, 66% reported CAS with at least one male partner of negative or unknown HIV serostatus in the six months prior to enrollment.

Longitudinal Changes in Treatment Optimism

At baseline, the prevalence of treatment optimism due to low perceived severity of HIV was 13% overall – 12% among HIV-uninfected men, 14% among HIV-infected men who were newly diagnosed, and 20% among HIV-infected men who were previously diagnosed (p=0.001). During the study period, the overall prevalence of treatment optimism decreased from 13% at baseline to 8% at month 12 (Figure 1). Among HIV-uninfected participants, the prevalence of treatment optimism decreased from 12% at baseline to 7% at month 12 (p<0.001). Among HIV-infected participants who were newly diagnosed, the prevalence decreased from 14% at baseline to 9% at month 12 (p=0.25). Among HIV-infected participants who were previously diagnosed, the prevalence decreased from 20% at baseline to 16% at month 12 (p=0.046).

Correlates of Treatment Optimism

Correlates of treatment optimism in longitudinal analysis are presented in Table II. Younger participants (ages 18-24 and 25-34 years) were less likely to have treatment optimism beliefs than older participants (≥35 years of age) (aOR=0.44 [95% CI: 0.30-0.66] for those aged 18-24; aOR=0.45 [95% CI: 0.30-0.67] for those aged 25-34). Men with lower annual household incomes (<$20,000 versus ≥$50,000) were more likely to have treatment optimism beliefs (aOR=1.93 [95% CI: 1.12, 3.33]). Psychosocial and behavioral factors that were associated with greater treatment optimism included symptoms of depression (aOR=1.30 [95% CI: 1.01, 1.67]), high HIV conspiracy beliefs (aOR=1.84 [95% CI: 1.24, 2.73]), and problematic alcohol use (aOR=1.37 [95% CI: 1.06, 1.77]). Though not significant in the multivariable model, high perceived racism, history of intimate partner violence, and stimulant use in the last six months were all correlates of treatment optimism in bivariable analyses. Having previously received an HIV diagnosis (versus not having received an HIV diagnosis, regardless of actual HIV status assessed during HIV testing after

the ACASI) was associated with treatment optimism after adjusting for covariates (aOR=1.50 [95% CI: 1.12-2.02]).

Association Between Treatment Optimism and Subsequent HIV Risk Behaviors

HIV-Uninfected Men—Among participants who were HIV-uninfected at baseline, there was not a statistically significant association between treatment optimism and CAS with at least one male partner of positive or unknown HIV status in the next six months (aOR=1.21 [95% CI: 0.81-1.81]), after adjusting for study city, internalized homophobia, perceived racism, perceived sexual discrimination, beliefs of HIV conspiracy theories, and history of intimate partner violence (Table III).

HIV-Infected Men—Among participants confirmed HIV-infected at baseline, treatment optimism was significantly associated with a greater likelihood of CAS with at least one male partner of negative or unknown HIV status in the next six months (aOR=2.10 [95% CI: 1.10-4.03]), after adjusting for study city, age, perceived racism, perceived sexual discrimination, high internalized HIV stigma, beliefs of HIV conspiracy theories, and history of intimate partner violence (Table III).

DISCUSSION

Using data collected from a large prospective cohort of BMSM in six US cities, we examined the prevalence and correlates of treatment optimism due to low perceived severity of HIV, and assessed the association of treatment optimism with subsequent sexual risk behaviors. Although BMSM represent the US subpopulation with the highest HIV incidence, previous studies of treatment optimism have largely neglected to collect or report data for BMSM. In addition, nearly all previous quantitative studies of treatment optimism were cross-sectional, which has led to the inability of studies to establish temporality of the association between treatment optimism and individual sexual risk behaviors (6). This longitudinal analysis provides evidence that, among HIV-infected BMSM, reduced-severity treatment optimism is an independent predictor of subsequent CAS with male partner(s) of negative or unknown HIV status. Although we found a weak positive association, among HIV-uninfected BMSM, between reduced-severity treatment optimism and subsequent CAS with male partner(s) of positive or unknown HIV status, this association was not statistically significant.

Many BMSM agreed or somewhat agreed that they felt comfortable having condomless sex due to the availability of HIV treatment. Based on our dichotomized measure for treatment optimism attributed to low perceived severity of HIV, the overall prevalence of treatment optimism was modest but there were notable differences by HIV status: approximately 1 in 5 men previously diagnosed with HIV at enrollment endorsed treatment optimism beliefs, compared with approximately 1 in 8 men newly diagnosed with HIV, and 1 in 9 HIV-uninfected men. Previous research findings have similarly indicated that people living with HIV tend to demonstrate greater reduced-severity and reduced-susceptibility treatment optimism beliefs (18, 46). Previous studies that measured treatment optimism have largely reported descriptive statistics for continuous measures of treatment optimism (e.g., the mean or median of a scaled score); however, two studies of MSM did similarly report prevalence

estimates using a dichotomous measure of treatment optimism, though these data are nearly two decades old. Based on a survey of HIV-uninfected MSM aged 23-29 in seven metropolitan areas of the US between 1998-2000, the belief that antiretroviral therapy mitigates HIV severity was present in 22% of Black and 10% of White participants and the belief that antiretroviral therapy mitigates HIV susceptibility was present in 7% of Black and 14% of White participants (12). Among HIV-uninfected MSM in 11 states between 2000-2001, 15% reported optimism-related risk behavior, i.e., being “less careful about being safe with sex and drugs” than they were five years ago because of the availability of effective treatments for HIV (31).

Interestingly, the proportion of participants who endorsed treatment optimism beliefs decreased between enrollment and month 12. Although this temporal change was only statistically significant for HIV-uninfected and previously diagnosed participants, the lack of statistical significance among participants newly diagnosed with HIV can likely be attributed to the smaller sample size of this subgroup. The decrease in the prevalence of treatment optimism over time suggests that the HPTN 061 study intervention may have influenced treatment-related optimistic beliefs during the yearlong study period. Participants received HIV/STI counseling and testing every six months, referral for care, and the opportunity to work with a Peer Health Navigator whose role was to facilitate the uptake of relevant health care and other services such as substance use or mental health services. Engagement of participants with culturally competent study staff trained to meet the unique psychosocial needs of BMSM may have contributed to a greater likelihood of participants to report (via ACASI) and/or develop intentions to engage in protective behaviors to prevent HIV/STI acquisition or transmission such as condom use as well as less optimistic perceptions of the severity of HIV infection. Although the counselors and study nurses might have reinforced that HIV is increasingly manageable, their messages about the importance of adherence to both clinic visits and medications might have also reinforced a sense that HIV care is life-long and requires sustained engagement.

Treatment optimism was associated with various demographic, psychosocial, and behavioral factors. Having previously received an HIV diagnosis remained associated with treatment optimism after adjusting for other covariates. Men aged ≥35 years were more likely to endorse treatment optimism beliefs, which is consistent with previous research findings that older age was associated with greater optimism (14, 46). Older MSM may be more cognizant of the dramatic improvements in antiretroviral therapy over the past two decades. Although this finding might seem to suggest that treatment optimism would therefore mostly influence HIV risk among older BMSM, it also has important implications for HIV risk among younger BMSM: research has suggested that a greater likelihood of having older, same-race sex partners may explain some of the disparity in HIV risk between Black and White young MSM (47-49). Younger BMSM may not only be more likely to have older partners who are living with HIV (since older versus younger and Black versus White MSM are more likely to have HIV, and Black versus White MSM with HIV are less likely to achieve viral suppression), but consequently also more likely to have partners who feel more comfortable having condomless sex due to low perceived severity of HIV. Among the sample, men who had HIV conspiracy beliefs were more likely to report being comfortable having CAS due to optimistic treatment beliefs, although only HIV-infected men who

endorsed conspiracy beliefs were actually more likely to report CAS with serodiscordant or unknown-status partners at the next visit. In fact, HIV-uninfected men who had conspiracy beliefs had a lower likelihood of reporting CAS with an HIV-infected or unknown-status partner. Bogart and colleagues previously found that HIV conspiracy beliefs among Black men were associated with negative condom attitudes and a greater likelihood of having condomless sex, possibly because people who hold conspiracy beliefs may be suspicious of HIV prevention messages and therefore less inclined to endorse protective behaviors such as condom use (41, 50). This inconsistency in our results should be further explored and it might be explained by participants' partner-level characteristics, as the definition of our outcome variable for CAS incorporated the self-reported HIV status of one's partners. Our finding that problematic alcohol use was associated with treatment optimism also warrants additional investigation, as some studies have found an association between alcohol consumption and condomless sex (51). A previous study found that anxiety was associated with increased treatment optimism; we similarly found that depressive symptoms were associated with treatment optimism (52).

Most notably, treatment optimism due to low perceived HIV severity was independently associated with subsequent CAS with a male partner of serodiscordant or unknown HIV status among HIV-infected study participants, though this association was not statistically significant among HIV-uninfected participants. Thus, our findings expand upon those of previous cross-sectional studies that reported a positive association between treatment optimism and HIV transmission risk behaviors by establishing temporality of this association among HIV-infected men, whereby treatment optimism was associated with greater odds of subsequent HIV transmission risk behaviors. More specifically, treatment optimism conferred a 110% increased odds of engaging in HIV transmission risk behaviors in the next six months among HIV-infected men. Though not significant, a weak positive association was evident among HIV-uninfected men, whereby treatment optimism conferred a 21% increased odds of engaging in HIV acquisition risk behaviors in the next six months. A previous study similarly found a stronger association between reduced HIV concern and sexual risk behavior among HIV-infected versus HIV-uninfected MSM (53). It is possible that this study lacked statistical power to detect a weak positive association among HIV-uninfected men, particularly since a smaller proportion of HIV-uninfected men endorsed treatment optimism beliefs compared with HIV-infected men. These findings underscore the likely influence of treatment optimism on subsequent risk behaviors among BMSM, particularly among those diagnosed with HIV and at risk of transmitting HIV to others.

Treatment optimism-related condomless serodiscordant sex may be problematic for two reasons. If HIV-infected persons are not virologically suppressed, they can transmit HIV to their partners. Recent studies have found no HIV transmission when HIV-infected persons are virologically suppressed for at least six months (20, 21). However, condomless, non-monogamous sex can also result in the transmission of other STIs even in the setting of viral suppression of HIV. Thus, interventions to address treatment optimism represent an important potential HIV prevention opportunity for BMSM who are at least somewhat comfortable having CAS due, in part, to the availability of antiretroviral therapy for HIV treatment. Interventions should incorporate education about the importance of medication adherence and routine testing for treatable STIs. Moreover, with the increasing use of PrEP

for HIV prevention, PrEP optimism may analogously create another treatment-related belief that could influence sexual risk behaviors.

This analysis should be interpreted within the context of several limitations. Our measure for treatment optimism was based on two survey items asked of participants via ACASI as part of the HPTN 061 study, so we were unable to utilize a validated psychometric scale consisting of three or more items. Moreover, the two items represented measures for reduced-severity optimism; thus, we were unable to consider reduced-susceptibility optimism, i.e., a belief in reduced susceptibility to HIV due to the suppressive effect of antiretroviral therapy on the viral load of infected sexual partners. Data on most variables were obtained via self-report, which may not reflect actual behaviors for various reasons (e.g., poor recall, social desirability bias); however, ACASI technology was used to minimize social desirability bias (54). Although retention of HPTN 061 participants was relatively high (80% and 75% at 6 and 12 months post-enrollment, respectively), this loss to follow-up reduced the analytic sample size in longitudinal analyses and was greater among HIV-infected participants. This analysis utilized data collected between 2009-2011 prior to US FDA approval of Truvada as PrEP as well as prior to recent data indicating no HIV transmission when HIV-infected partners were virologically suppressed, but data collected in HPTN 061 are considerably more recent than the large majority of studies that have investigated treatment optimism among MSM or BMSM. HPTN 061 was a research study and, thus, the extent to which it replicates real-world settings may be limited; for instance, the men who were willing and able to participate in a longitudinal research study may not be a representative sample of the population of US BMSM. Despite these limitations, this analysis was the first to utilize data on treatment optimism collected from a prospective cohort of BMSM.

CONCLUSIONS

This analysis provides compelling evidence that treatment optimism due to low perceived severity of HIV influences the likelihood of subsequent HIV transmission risk behaviors among HIV-infected BMSM. It also provides suggestive evidence that treatment optimism might similarly influence the likelihood of subsequent HIV acquisition risk behaviors among HIV-uninfected BMSM, though to a lesser extent. Providers of HIV prevention and care services should engage men in point-of-care counseling conversations to assess and minimize their willingness to have condomless sex with partners of serodiscordant or unknown status by providing evidence-based information on the risk of HIV acquisition or transmission associated with certain risk behaviors and by specifically addressing a willingness to engage in high-risk behaviors that is rooted in optimistic beliefs regarding HIV treatment. Given the current HIV prevention landscape of emerging biomedical approaches to prevention, future studies of BMSM should also measure other relevant types of treatment optimism such as PrEP optimism; the increasing awareness, availability, and use of PrEP may similarly influence the willingness of men to engage in condomless sex. This analysis contributes to a better understanding of treatment optimism among BMSM and warrants additional research on perceptions of biomedical HIV interventions among populations at greatest risk of HIV.

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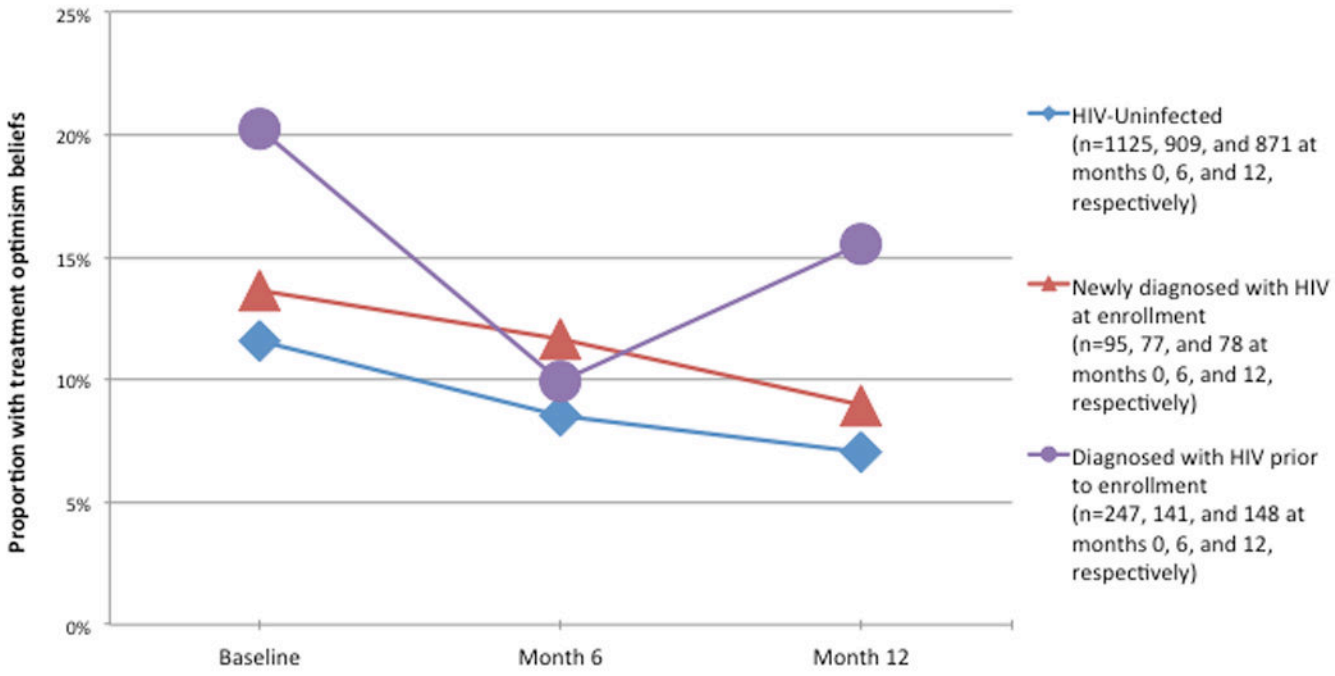

Figure 1. Longitudinal changes in treatment optimism due to low perceived severity of HIV

The prevalence of treatment optimism was assessed at each study visit stratified by HIV status among participants who had a non-missing value for treatment optimism. Data for participants who were HIV-uninfected at baseline and seroconverted during the study follow-up period are not presented in this figure.

Table I

Baseline characteristics of a cohort of Black men who have sex with men (n=1515).

Variable	HIV–(n=1167)[a] n[b] (%)	HIV+, Newly Diagnosed (n=96)[a] n[b] (%)	HIV+, Previously Diagnosed (n=252)[a] n[b] (%)	χ^2	p
Socio-Demographics					
Age (years)				64.3	**<0.001**
18-24	277 (23.7)	20 (20.8)	12 (4.8)		
25-34	231 (19.8)	20 (20.8)	33 (13.1)		
≥35	659 (56.5)	56 (58.3)	207 (82.1)		
City				52.5	**<0.001**
Atlanta and Decatur, GA	224 (19.2)	25 (26.0)	37 (14.7)		
San Francisco, CA	174 (14.9)	2 (2.1)	23 (9.1)		
New York City, NY	224 (19.2)	26 (27.1)	47 (18.7)		
Boston, MA	191 (16.4)	6 (6.3)	37 (14.)		
Los Angeles, CA	189 (16.2)	17 (17.7)	75 (29.8)		
Washington, DC	165 (14.1)	20 (20.8)	33 (13.1)		
Has college degree or higher	534 (45.8)	34 (35.4)	117 (46.4)	4.0	0.13
Annual household income				14.8	**0.005**
<$20,000	671 (58.2)	61 (63.5)	169 (67.6)		
$20,000-49,999	334 (28.9)	28 (29.2)	67 (26.8)		
≥$50,000	149 (12.9)	7 (7.3)	14 (5.6)		
Treatment Optimism Due to Low Perceived Severity of HIV [c]	134 (11.6)	13 (13.7)	50 (20.2)	13.2	**0.001**
Psychosocial Factors					
Depressive symptoms (CES-D > 16)	471 (43.7)	38 (44.2)	114 (48.7)	2.0	0.37
Social support				3.7	0.45
High	475 (43.0)	47 (50.0)	113 (47.3)		
Moderate	372 (33.6)	31 (33.0)	74 (31.0)		
Low	259 (23.4)	16 (17.0)	52 (21.8)		
Internalized homophobia				15.4	**0.004**
High	96 (8.7)	7 (7.6)	13 (5.4)		

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Variable	HIV–(n=1167)[a] n[b] (%)	HIV+, Newly Diagnosed (n=96)[a] n[b] (%)	HIV+, Previously Diagnosed (n=252)[a] n[b] (%)	χ^2	p
Medium	408 (37.1)	28 (30.4)	65 (27.1)		
Low	597 (54.2)	57 (62.0)	162 (67.5)		
Perceived racism				1.1	0.89
High	240 (23.1)	16 (18.8)	47 (21.2)		
Medium	492 (47.4)	43 (50.6)	107 (48.2)		
Low	307 (29.6)	26 (30.6)	68 (30.6)		
Perceived sexual discrimination				6.2	0.19
High	190 (19.1)	9 (11.0)	36 (17.6)		
Medium	385 (38.7)	41 (50.0)	88 (42.9)		
Low	421 (42.3)	32 (39.0)	81 (39.5)		
High internalized HIV stigma	494 (44.0)	45 (47.9)	110 (45.6)	0.7	0.72
Beliefs of conspiracy theories surrounding HIV				2.0	0.73
High	94 (8.5)	9 (10.3)	23 (9.8)		
Medium	431 (39.2)	38 (43.7)	96 (41.0)		
Low	576 (52.3)	40 (46.0)	115 (49.2)		
History of intimate partner violence	588 (52.0)	57 (60.0)	147 (60.0)	6.7	**0.034**
Alcohol and Drug Use					
Problematic alcohol use [d]	378 (33.9)	23 (24.7)	58 (24.6)	10.1	**0.006**
Stimulant use in the last 6 months	426 (38.0)	35 (37.2)	95 (40.6)	0.6	0.74
Injection drug use in the last 6 months	58 (5.1)	5 (5.2)	11 (4.4)	0.2	0.91
Anal Sex with Male Partners in the Last 6 Months					
Number of male anal sex partners				13.4	0.10
1	200 (17.2)	14 (14.6)	60 (23.8)		
2-3	411 (35.3)	29 (30.2)	77 (30.6)		
4-5	217 (18.6)	25 (26.0)	43 (17.1)		
6-9	165 (14.2)	12 (12.5)	28 (11.1)		
≥10	171 (14.7)	16 (16.7)	44 (17.5)		
Condomless anal sex (CAS) with ≥1 male partner of serodiscordant or unknown HIV status	593 (51.2)	78 (81.3)	147 (60.5)	36.3	**<0.001**

CES-D, Center for Epidemiology Studies Depression Scale ; CAS, condomless anal sex.

[a] Baseline data are provided for all participants who had non-missing values for HIV status at baseline, which excluded 38 of the 1553 total participants in HPTN 061.

[b] Frequency counts (n) may not add to total due to missing values.

[c] Treatment optimism due to low perceived severity of HIV was defined as agreeing or somewhat agreeing with at least one of two items: “I feel comfortable having unprotected sex because treatments for HIV will continue to improve” and “I feel comfortable having unprotected sex because HIV can be easily managed now.”

[d] Defined as a score ≥8 on the Alcohol Use Disorders Identification Test (AUDIT).

Table II

Correlates of treatment optimism due to low perceived severity of HIV in multivariable longitudinal analysis (n=1510).[a]

Variable	OR (95% CI)	p	aOR (95% CI)[b]	p
Socio-Demographics				
City				
Atlanta and Decatur, GA	1.04 (0.65, 1.68)	0.86	0.65 (0.39, 1.07)	0.087
San Francisco, CA	**1.63 (1.02, 2.59)**	**0.039**	1.02 (0.62, 1.68)	0.94
New York City, NY	1.27 (0.80, 2.01)	0.31	0.82 (0.50, 1.35)	0.44
Boston, MA	**1.74 (1.09, 2.78)**	**0.021**	1.03 (0.63, 1.70)	0.91
Los Angeles, CA	1.06 (0.65, 1.71)	0.82	0.66 (0.40, 1.10)	0.11
Washington, DC	ref		ref	
Age (years)				
18-24	**0.38 (0.26, 0.55)**	**<0.001**	**0.44 (0.30, 0.66)**	**<0.001**
25-34	**0.42 (0.28, 0.63)**	**<0.001**	**0.45 (0.30, 0.67)**	**<0.001**
≥35	ref		ref	
Has college degree or higher	**0.75 (0.58, 0.97)**	**0.026**	‡	
Annual household income				
<$20,000	**2.38 (1.43, 3.96)**	**<0.001**	**1.93 (1.12, 3.33)**	**0.019**
$20,000-49,999	1.60 (0.93, 2.77)	0.092	1.41 (0.80, 250)	0.24
≥$50,000	ref		ref	
Psychosocial Factors				
Depressive symptoms [c]	**1.50 (1.18, 1.90)**	**0.001**	**1.30 (1.01, 1.67)**	**0.045**
Social support [c]				
High	ref		‡	
Moderate	1.07 (0.82, 1.39)	0.61	‡	
Low	1.31 (0.97, 1.76)	0.077	‡	
Internalized homophobia [c]				
High	1.31 (0.86, 1.97)	0.21	†	
Medium	1.10 (0.86, 1.42)	0.45	†	
Low	ref		†	
Perceived Racism [c]				
High	**1.68 (1.20, 2.33)**	**0.002**	‡	
Medium	1.17 (0.91, 1.50)	0.22	‡	
Low	ref		‡	
Perceived sexual discrimination [c]				
High	1.38 (0.99, 1.94)	0.060	‡	
Medium	1.07 (0.81, 1.40)	0.64	‡	
Low	ref		‡	
High internalized HIV stigma [c]	1.13 (0.90, 1.42)	0.30	†	
Beliefs of conspiracy theories surrounding HIV [c]				

Variable	OR (95% CI)	p	aOR (95% CI)[b]	p
High	**1.99 (1.35, 2.94)**	**<0.001**	**1.84 (1.24, 2.73)**	**0.003**
Medium	1.26 (0.98, 1.61)	0.068	1.23 (0.96, 1.59)	0.10
Low	ref		ref	
History of intimate partner violence [c]	**1.30 (1.05, 1.61)**	**0.014**	‡	
Alcohol and Drug Use				
Problematic alcohol use [c]	**1.46 (1.15, 1.87)**	**0.002**	**1.37 (1.06, 1.77)**	**0.015**
Stimulant use in the last 6 months [c]	**1.27 (1.00, 1.62)**	**0.048**	‡	
Injection drug use in the last 6 months [c]	1.49 (0.95, 2.35)	0.084	‡	
Previously known to have HIV [c]	**1.61 (1.22, 2.13)**	**<0.001**	**1.50 (1.12, 2.00)**	**0.006**

OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio.

†Not considered for inclusion in the multivariable model because p≥0.10 in the univariable model.

‡Eliminated from the multivariable model using a manual stepwise method because p≥0.05.

[a]These regression analyses were conducted among all participants who had non-missing values for HIV status and treatment optimism.

[b]The multivariable model included city and all covariates that remained significant at p<0.05: age, income, depressive symptoms, beliefs of HIV conspiracy theories, problematic alcohol use, and previously knowing one's HIV-positive status prior to the respective study visit.

[c]Time-updated covariate.

Table III

Longitudinal multivariable analysis of the association of treatment optimism and covariates with subsequent condomless anal sex with a male partner of serodiscordant or unknown HIV status within 6 months (n=1123).

	HIV-Uninfected Men (n=908)[a]				HIV-Infected Men (n=215)[a]			
	Condomless Anal Sex (CAS) with ≥1 male partner of HIV-positive or unknown status within 6 months				Condomless Anal Sex (CAS) with ≥1 male partner of HIV-negative or unknown status within 6 months			
Variable	**OR (95% CI)[b]**	**p**	**aOR (95% CI)[c]**	**p**	**OR (95% CI)[b]**	**p**	**aOR (95% CI)[d]**	**p**
Treatment Optimism Due to Low Perceived Severity of HIV [e]	1.14 (0.77, 1.69)	0.50	1.21 (0.81, 1.81)	0.35	**2.11 (1.16, 3.82)**	**0.014**	**2.10 (1.10, 4.03)**	**0.025**
Socio-Demographics								
City								
Atlanta and Decatur, GA	**0.62 (0.39, 1.00)**	**0.049**	0.69 (0.42, 1.12)	0.13	1.50 (0.70, 3.20)	0.29	2.01 (0.90, 4.52)	0.089
San Francisco, CA	0.76 (0.47, 1.25)	0.92	0.76 (0.46, 1.26)	0.29	0.30 (0.07, 1.26)	0.10	0.43 (0.10, 1.79)	0.24
New York City, NY	0.75 (0.48, 1.19)	0.23	0.81 (0.50, 1.29)	0.37	0.48 (0.22, 1.06)	0.069	0.56 (0.24, 1.32)	0.19
Boston, MA	**0.55 (0.33, 0.90)**	**0.017**	**0.57 (0.34, 0.95)**	**0.033**	0.88 (0.35, 2.18)	0.78	1.01 (0.37, 2.74)	0.99
Los Angeles, CA	0.84 (0.52, 1.37)	0.49	0.88 (0.54, 1.46)	0.63	0.52 (0.22, 1.21)	0.13	0.62 (0.26, 1.50)	0.29
Washington, DC	ref		ref		ref		ref	
Age (years)								
18-24	1.26 (0.89, 1.77)	0.20	†		1.30 (0.49, 3.46)	0.60	1.53 (0.54, 4.34)	0.43
25-34	1.04 (0.72, 1.51)	0.82	†		1.78 (0.99, 3.17)	0.053	1.20 (0.64, 2.26)	0.57
≥35	ref		†		ref		ref	
Has college degree or higher	1.01 (0.77, 1.33)	0.92	†		1.49 (0.88, 2.53)	0.14	†	
Annual household income								
<$20,000	0.92 (0.59, 1.43)	0.71	†		0.93 (0.33, 2.57)	0.88	†	
$20,000-49,999	1.29 (0.81, 2.05)	0.28	†		1.55 (0.55, 4.42)	0.41	†	
≥$50,000	ref		†		ref		†	
Psychosocial Factors								
Depressive symptoms [e]	1.13 (0.88, 1.45)	0.33	†		0.99 (0.59, 1.66)	0.96	†	
Social support [e]								
High	ref		†		ref		†	
Moderate	1.12 (0.85, 1.47)	0.42	†		1.08 (0.63, 1.87)	0.77	†	

	HIV-Uninfected Men (n=908)[a]				HIV-Infected Men (n=215)[a]			
	Condomless Anal Sex (CAS) with ≥1 male partner of HIV-positive or unknown status within 6 months				Condomless Anal Sex (CAS) with ≥1 male partner of HIV-negative or unknown status within 6 months			
Variable	**OR (95% CI)[b]**	**p**	**aOR (95% CI)[c]**	**p**	**OR (95% CI)[b]**	**p**	**aOR (95% CI)[d]**	**p**
Low	1.11 (0.81, 1.52)	0.52	†		1.69 (0.88, 3.23)	0.11	†	
Internalized homophobia [e]								
High	0.75 (0.47, 1.20)	0.24	0.79 (0.48, 1.29)	0.35	0.35 (0.08, 1.59)	0.17	†	
Medium	**0.75 (0.57, 0.97)**	**0.032**	0.79 (0.60, 1.04)	0.092	1.44 (0.88, 2.38)	0.15	†	
Low	ref		ref		ref		†	
Perceived racism [e]								
High	0.98 (0.71, 1.35)	0.88	0.99 (0.58, 1.70)	0.97	**2.04 (1.04, 4.02)**	**0.038**	1.36 (0.34, 5.54)	0.66
Medium	1.26 (0.97, 1.64)	0.080	0.97 (0.67, 1.41)	0.88	1.53 (0.92, 2.55)	0.10	1.61 (0.56, 4.61)	0.38
Low	ref		ref		ref		ref	
Perceived sexual discrimination [e]								
High	0.88 (0.60, 1.30)	0.53	0.82 (0.44, 1.51)	0.53	**2.13 (1.05, 4.32)**	**0.037**	1.18 (0.29, 4.77)	0.82
Medium	**1.60 (1.23, 2.09)**	**<0.001**	**1.57 (1.06, 2.31)**	**0.024**	1.13 (0.66, 1.94)	0.66	0.65 (0.21, 2.03)	0.46
Low	ref		ref		ref		ref	
High internalized HIV stigma [e]	1.11 (0.88, 1.40)	0.37	†		**2.31 (1.47, 3.63)**	**<0.001**	**1.85 (1.14, 3.01)**	**0.013**
Beliefs of conspiracy theories surrounding HIV [e]								
High	0.67 (0.39, 1.15)	0.15	0.76 (0.44, 1.31)	0.32	**2.27 (1.01, 5.09)**	**0.046**	1.65 (0.68, 3.99)	0.26
Medium	**0.77 (0.60, 1.00)**	**0.048**	0.81 (0.62, 1.06)	0.13	1.29 (0.77, 2.16)	0.34	1.22 (0.68, 2.21)	0.50
Low	ref		ref		ref		ref	
History of intimate partner violence [e]	**1.28 (1.02, 1.61)**	**0.036**	1.28 (0.99, 1.64)	0.054	2.09 (1.33, 3.29)	0.001	1.80 (1.07, 3.03)	0.027
Alcohol and Drug Use								
Problematic alcohol use [e]	1.18 (0.91, 1.54)	0.21	†		1.13 (0.64, 2.01)	0.67	†	
Stimulant use in the last 6 months [e]	1.12 (0.86, 1.46)	0.42	†		1.51 (0.88, 2.60)	0.13	†	
Injection drug use in the last 6 months [e]	0.83 (0.47, 1.47)	0.53	†		1.17 (0.29, 4.74)	0.82	†	
Newly Diagnosed with HIV at Baseline	N/A		N/A		0.93 (0.53, 1.64)	0.81	†	

† Not included in the multivariable model because p≥0.10 in the univariable model.

OR, odds ratio; CI, confidence interval; aOR, adjusted odds ratio.

[a] These regression analyses were conducted among participants who had non-missing values for HIV status at baseline. Participants who were HIV-uninfected at baseline and seroconverted during the study follow-up period were excluded. For each participant, all non-missing values for treatment optimism at baseline and month 6 and corresponding non-missing values for the outcome variable (condomless anal sex with a male partner of serodiscordant or unknown HIV status in the past 6 months) at month 6 and month 12, respectively, were included.

[b] Adjusted for baseline condomless anal sex with a male partner of serodiscordant or unknown HIV status in the past 6 months.

[c] Treatment optimism, baseline condomless anal sex with a male partner of serodiscordant or unknown HIV status in the past 6 months, and all covariates significant at $p<0.10$ in univariable models were included in the multivariable model: city, depressive symptomatology, social support, internalized homophobia, perceived racism, beliefs of HIV conspiracy theories, and intimate partner violence.

[d] Treatment optimism, city, baseline condomless anal sex with a male partner of serodiscordant or unknown HIV status in the past 6 months, and all additional covariates significant at $p<0.10$ in univariable models were included in the multivariable model: city, social support, perceived racism, high internalized HIV stigma, beliefs of HIV conspiracy theories, and intimate partner violence.

[e] Time-updated covariate.