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ORIGINAL PAPER

Sexual Risk Behavior and Risk Reduction Beliefs Among HIV-Positive Young Men Who have Sex with Men

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Abstract With young men who have sex with men (YMSM) continuing to be disproportionately affected by the HIV/AIDS epidemic in the U.S., secondary prevention efforts with this population take on increasing significance. We surveyed 200 HIV-positive YMSM (ages 16–24, 66% Black, 18% Latino, 7% White, 7% Multiracial/Other) recruited from 14 HIV primary care sites to examine associations of unprotected anal intercourse (UAI) and partner HIV status with endorsement of serosorting, sexual positioning, and viral load beliefs. Proportions of participants engaging in UAI one or more times during the past three months were consistent across type of UAI (insertive or receptive) and partner status. Belief that an undetectable viral load reduces infectiousness was significantly associated with insertive UAI ($p < .05$) and receptive UAI ($p < .05$) with HIV-negative or unknown status partners and receptive UAI with HIV-positive partners ($p < .01$). Endorsement of belief in serosorting was significantly associated with receptive UAI ($p < .01$) and insertive UAI ($p < .05$) with HIV-positive male partners. Implications for sexual behavior and risk reduction beliefs in this population are discussed.

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Resumen Los hombres jóvenes que mantienen relaciones sexuales con otros hombres (YMSM) continúan siendo afectados de manera desproporcionada por la epidemia del VIH/SIDA en los EE.UU. Por lo tanto, los esfuerzos de prevención secundaria con esta comunidad tienen una significación cada vez mayor. En este estudio, se encuestó a 200 YMSM seropositivos (de entre 16 y 24 anos, el 66% afro-americano, 18% hispano, 7% el blanco-americano, el 7% multirracial/otro grupo étnico) reclutados de 14 centros de atención primaria del VIH para examinar la correlación entre el sexo anal sin protección (UAI), el estado del VIH de la pareja sexual y la aprobación de "serosorting," posición sexual y las creencias de la carga viral. Lo proporción de los participantes involucrados en el UAI una o más veces durante los últimos tres meses fue consistente independientemente del tipo de UAI (insertivo o receptivo) o del estado del VIH de la pareja sexual. La aprobación de la carga viral se asoció significativamente con el UAI insertivo ($p < 0{,}05$) y receptivo ($p < 0{,}05$), con el estado VIH-negativo o desconocido, y con el UAI receptivo con una pareja que es VIH positivó ($p < 0{,}01$). La aprobación de "serosorting" se asoció significativamente con el UAI receptivo ($p < 0{,}01$) e insertivo ($p < 0{,}05$) y con una pareja que es VIH positivo. Implicaciones para el comportamiento sexual y las creencias acerca de la reducción del riesgo en esta comunidad se presentan aquí.

Introduction

Men who have sex with men (MSM) continue to represent the majority of HIV incidence and prevalence in the U.S.,

and young MSM (YMSM) constitute a greater proportion of new and existing HIV cases [1]. The estimated proportion of new HIV infections among adolescents and young adults (ages 13–24) attributable to male-to-male sexual transmission increased from 57% in 2005 to 68% in 2008 [1]. Among African American and Latino MSM, young men ages 13–29 constitute approximately half of all new infections for both ethnic groups of MSM [2]. Unprotected anal intercourse (UAI) accounts for the majority of HIV infections among MSM, and unprotected receptive anal intercourse is generally recognized as riskier than unprotected insertive anal intercourse [1, 3, 4].

As more and more persons living with HIV/AIDS live longer due to treatment advances, secondary prevention takes on increasing significance. Although condom use has been recognized as the most effective means of HIV prevention among sexually active individuals, some MSM living with HIV/AIDS have adopted a range of practices thought to reduce risk of HIV transmission, including selecting UAI partners of concordant HIV status (serosorting) and selectively engaging in receptive rather than insertive UAI with HIV-negative or status-unknown partners (sexual, or strategic, positioning). The effectiveness of serosorting in such cases largely depends on the knowledge and explicit disclosure of one's HIV status to sex partners [5]. Such risk reduction strategies may also be employed by HIV-negative MSM (as well as "negotiated safety," or the negotiation of eschewing condom use among seroconcordant negative couples), although the effectiveness of such strategies are dependent upon the testing frequency of HIV-negative men, i.e., the certainty with which MSM who presume themselves to be HIV-negative are actually correct regarding their serostatus [5–7]. In addition, it is generally recognized that having an undetectable viral load significantly reduces HIV transmission risk among persons living with HIV/AIDS [8, 9]. During the past decade, a body of research on secondary prevention and risk reduction trends among adult MSM living with HIV/AIDS has focused on serosorting, sexual or strategic positioning, and infectiousness beliefs regarding viral load [10–13]; yet, to date very little is known about risk reduction beliefs and practices among YMSM living with HIV/AIDS.

A meta-analysis of studies of adult MSM living with HIV/AIDS in the U.S. has estimated prevalence of UAI with HIV-positive partners to be 30%, approximately twice the estimated prevalence of UAI with HIV-negative or status-unknown partners (13 and 16%, respectively), with varying rates of insertive versus receptive anal intercourse [11]. Previous reviews have described trends that demonstrate higher rates of UAI among HIV-positive MSM than HIV-negative MSM, and greater likelihood of HIV-positive MSM engaging in UAI with other HIV-positive MSM, with inconclusive findings regarding evidence for sexual positioning practices [12, 13]. Other research has proposed that increases in sexually transmitted infections without a concurrent increase in HIV infection among communities of MSM might constitute evidence of serosorting practices among this population [14, 15].

Conclusions regarding serosorting and sexual positioning practices among MSM living with HIV/AIDS have been largely inferred from rates of sexual risk behavior among samples of these men, and studies examining associations between UAI and serosorting and sexual positioning beliefs have been less common in the literature. In one study, serosorting beliefs among seroconcordant HIV-positive male couples and seroconcordant HIV-negative male couples have been shown to reduce the couples' perceived need for condom use [16]. Sexual positioning beliefs are thought to be inferred from "a hierarchy of risks" present within HIV prevention education [17, 18], but little research has been performed that examines associations between specific sexual positioning beliefs and UAI.

Numerous studies have shown that rates of UAI increased among HIV-positive MSM in the years after the introduction of antiretroviral therapy (ART) [13, 19, 20]. It has been proposed that an undetectable viral load may render HIV transmission negligible [8, 9], although the research that informed these conclusions contained few data specific to MSM. Studies utilizing cross-sectional community samples of MSM from 1997 to 2007 have documented: (1) increases in beliefs that an undetectable viral load was associated with reduced transmission risk and (2) that these beliefs were associated with concurrent increases in UAI [21]. Furthermore, a review of research investigating ART and sexual risk behavior found that persons who believed that ART reduced transmission risk participated in more UAI [10].

There appear to be trends in HIV-negative men factoring an HIV-positive partner's viral load in the decision to engage in UAI to a degree greater than HIV-positive men using their own viral load in deciding to engage in UAI with HIV-negative partners. In their review of literature on ART and sexual risk behavior, Crepaz et al. [10] found no association among either undetectable viral load or ART use with UAI among HIV-positive persons, although a relationship was present when examining viral load or ART use and sexual risk behavior among HIV-negative populations. In subsequent studies of Australian MSM in serodiscordant relationships, HIV-negative men in the relationships were more likely to use their partner's undetectable viral load in their decisions to engage in UAI along with sexual positioning; conversely, the HIV-positive partners did not appear to factor their own viral load into their decisions to engage in UAI [22].

Few studies have examined UAI rates among YMSM with HIV/AIDS, and even less is known regarding risk reduction beliefs and practices among this population. Rates of UAI

have been estimated at 20–35% among a national clinic-based sample of HIV-positive YMSM [23, 24]. Recent findings have documented increased rates of condom use among recently diagnosed HIV-positive YMSM and decreased rates of condom use among those HIV-positive YMSM previously in care [24]. One study assessed the influence of ART on the sexual behavior of young persons living with HIV and reported that adherence to ART was significantly associated with increased condom use with recent sex partners [25]. To our knowledge, no research to date has reported on serosorting, sexual positioning, and beliefs about viral load and infectiousness among HIV-positive YMSM.

In this study, we assessed prevalence of insertive and receptive UAI with HIV-positive and HIV-negative partners or partners of unknown status among a sample of YMSM living with HIV/AIDS. We hypothesized that (1) agreement with serosorting belief would be significantly associated with UAI with HIV-positive partners, (2) agreement with sexual positioning belief would be significantly associated with receptive UAI with HIV-negative and status-unknown partners, and (3) the belief that an undetectable viral load makes one less infectious ("viral load belief") would be significantly associated with all four types of UAI. We also explored possible associations of the different types of UAI with participant characteristics such as being in a long-term relationship, having knowledge of one's viral load, and having an undetectable viral load.

Methods

Study Design

The data discussed in this paper were derived from Phase 2 of a two-phase study investigating associations among young HIV-positive MSM's racial identities, sexual orientation identities, and identities as HIV-positive young men with stressors, coping mechanisms, and health behaviors (ATN070). Data collection was conducted at 14 geographically and demographically diverse clinical care sites within the Adolescent Trials Network for HIV/AIDS Interventions (ATN).

Recruitment

Young HIV-positive men ages 16–24 who were receiving care within clinic settings at one of the sites were approached by study coordinators to assess study eligibility. In order to allay any concern by potential participants that they had been "identified" by the study coordinators, they were informed that all men in the clinic setting who appeared to be between the ages of 16–24 were approached and screened for the study. Inclusion criteria for the study was (1) biologically male at birth and identifies as male at time of study participation; (2) HIV-infected as documented by medical record review or verbal verification with referring professional; (3) HIV infection occurred through sexual or substance use behavior of the participant; (4) between the ages of 16 and 24 years at the time of informed consent/assent; ability to understand both written and spoken English; and (5) history of at least one sexual encounter involving either anal or oral penetration (either receptive or insertive) with a male partner during the 12 months prior to study enrollment. Study coordinators conducted a brief screening interview in a private room in order to determine eligibility; upon verification of eligibility, study coordinators then obtained signed consent/assent from participants.

Study Procedures

Since the population of interest for this study was young gay and bisexual men, the institutional review boards of each study site were requested to grant a waiver of parental permission to participate in the study for participants under the age of 18. This was done to avoid the selection biases present in recruiting only youth whose parents are both aware of and comfortable with their sexual orientation. The research protocol was approved by the institutional review boards at the investigators' home institution, and 13 of the clinical sites. The research protocol was amended at one clinical site to not include the waiver of parental permission, and as a result participants under the age of 18 at that site were not eligible to participate.

Once consent/assent was received, participants were enrolled in the study utilizing a confidential code that contained no identifying person information. An appointment to complete an audio computer assisted self-interview (ACASI) was scheduled for each participant by study coordinators at the sites. All interviews were completed on portable laptop computers. Data collected were saved in an encrypted format using ENTRUST encryption software and were not available for review by any clinical site personnel. The data were transmitted in encrypted form via a phone line directly to the ATN Data Operations Center (DOC) at Westat, Inc. Data were unencrypted at the DOC, processed further for construction of the study database, then sent to the principal investigator at DePaul for analysis. Compensation for participation was determined by each site and varied across the sites.

Measures

Demographic and HIV-Related Data

Various demographic variables of interest were collected including age, race/ethnicity, relationship status, education,

employment, and sexual orientation. In addition, self-reported HIV-specific data were collected, including being on antiretroviral therapy, knowing one's most recent CD4 count, knowing one's most recent viral load, and having an undetectable viral load.

Sexual Behavior

We assessed a range of same-sex sexual behavior over the past 3 months, including any oral or anal sexual behavior with other males, any anal intercourse with HIV-negative or unknown status male partners, and any anal intercourse with HIV-positive male partners. Sexual risk behavior was assessed across four types of UAI: (1) insertive UAI with male HIV-negative partner(s) or partner(s) of unknown status, (2) receptive UAI with male HIV-negative partner(s) or partner(s) of unknown status, (3) insertive UAI with male HIV-positive partner(s), and (4) receptive UAI with male HIV-positive partner(s). Participants were asked to report the number of times they had engaged in each type of UAI during the past 3 months.

Risk Reduction Beliefs

Attitudinal variables assessed participant beliefs regarding infectiousness and viral load, serosorting, and sexual positioning using a four-point response scale (1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree). Endorsement of viral load belief was assessed by agreement with the following item: "If my viral load is low or undetectable I am less likely to infect another person with HIV if I have unprotected sex." Endorsement of a belief in sexual positioning was assessed by agreement with the following item: "It is difficult for an HIV-positive man to transmit HIV if he is the 'bottom' (receptive)." Endorsement of a belief in serosorting was assessed by agreement with the following item: "I am less concerned about using condoms with a partner who is also HIV-positive."

Data Analysis

Data were examined for non-normality. Pearson correlation analyses were performed to examine inter-correlations among the variables. The sexual risk dependent variables were dichotomized into response categories of "never" and "one or more times." Because of the characteristics of the data, logistic regression models were developed using SPSS v.17 statistical software. Forward stepwise regression was used to determine significant predictors of the four sexual risk behavior outcomes of interest, reporting odds ratios, 95% confidence intervals, and levels of significance. Self-reported participant characteristics thought to be related to UAI (relationship status, knowledge of one's viral load, and having an undetectable viral load) were entered as covariates for all four models. The viral load belief variable was entered into all four models. The serosorting belief variable was entered into the models predicting insertive and receptive UAI with HIV-positive partners (Models 3 and 4, respectively). The sexual positioning belief variable was entered into the models predicting receptive UAI with HIV-negative or status-unknown partners (Model 2) and receptive UAI with HIV-positive partners (Model 4).

Results

Participant Characteristics

Participant characteristics are presented in Table 1. Two-thirds of the sample identified as Black or African American

Table 1 Participant characteristics ($n = 200$)

	M	SD
Age	21.1	1.91
	n	%
Ethnicity		
African American or Black	132	66.0
Hispanic/Latino	37	18.5
Non-Hispanic White	14	7.0
Native American/American Indian	2	1.0
Asian American/Pacific Islander	1	0.5
Other/mixed	14	7.0
Sexual orientation		
Gay/homosexual/queer	156	78.0
Bisexual	24	12.0
Straight/trade/down low	11	5.5
Questioning	2	1.0
Other	7	3.5
Education		
Did not complete high school	53	26.5
High school graduate	74	37.0
Some college or technical school	62	31.0
College/technical school graduate	9	4.5
Graduate school, not yet completed	2	1.0
Employment		
Full-time	44	22.0
Part-time	47	23.5
Unemployed	109	54.5
In a long-term relationship	41	20.5
Currently on ART	94	47.0
Knows his CD4 count	118	59.0
Knows his viral load	78	39.0
Has undetectable viral load	30	15.0

Table 2 Distribution of risk reduction beliefs ($n = 200$)

	M	SD	Skew.	SE Skew.
Viral load belief[a]	2.18	1.04	0.260	0.175
Serosorting belief[a]	1.86	0.99	0.838	0.173
Sexual positioning belief[a]	1.86	0.86	0.460	0.172

[a] Responses ranged from 1 (strongly disagree) to 4 (strongly agree)

and over three-quarters identified as gay, homosexual, or queer. Approximately one in five participants reported currently being in a long-term relationship for 1 year or more. Slightly less than half of the sample was currently on antiretroviral therapy, approximately 40% reported knowing their viral load, and only 15% stated that they were currently undetectable.

Risk Reduction Beliefs

Table 2 summarizes the risk reduction beliefs assessed. There was a higher degree of endorsement for belief in less infectiousness with low or undetectable viral load than for endorsement of the serosorting and sexual positioning items. More participants disagreed with the serosorting and sexual positioning statements, while slightly more agreed with the statement regarding viral load and infectiousness. Despite the equivalence of the mean scores of the sexual positioning and serosorting items, the endorsement of the sexual positioning belief was strongly skewed toward the disagreement end of the scale, with a much larger proportion of the participants strongly disagreeing as opposed to strongly agreeing with endorsing the belief in sexual positioning.

Sexual Behavior

Sexual behavior across the sample is summarized in Table 3. Ninety-two percent of the participants reported being sexually active in the past 3 months, with roughly two-thirds reporting anal intercourse with HIV-negative or unknown status partners and approximately 40% reporting anal intercourse with HIV-positive partners.

In terms of sexual risk behavior, 43% of the sample reported participating in at least one type of UAI during the past 3 months. Proportions engaging in specific types of UAI were fairly consistent across the types: 20.5% reported insertive UAI with HIV-negative/unknown status; 22.5% receptive UAI with HIV-negative/unknown status; 21.5% insertive UAI with HIV-positive; 21.0% receptive UAI with HIV-positive. Eleven (5.5%) participants reported engaging in all four types of UAI during the past 3 months.

Table 3 Sexual behavior in past 3 months ($n = 200$)

	n	%
Any sexual behavior (oral, anal)	184	92.0
Any HIV-negative or unknown status anal intercourse partners	129	64.5
Any HIV-positive anal intercourse partners	81	40.5
Any unprotected anal intercourse (UAI)	86	43.0
Insertive UAI with any HIV-negative or unknown status partner	41	20.5
Receptive UAI with any HIV-negative or unknown status partner	45	22.5
Insertive UAI with any HIV-positive partner	43	21.5
Receptive UAI with any HIV-positive partner	42	21.0
Reporting all 4 types of UAI	11	5.5

Regression Analysis

Regression models adjusted for being in a long-term relationship, knowing one's own viral load, and having an undetectable viral load are summarized in Table 4.

Model 1 statistically predicted insertive UAI w/HIV-negative partners or partners of unknown status ($\chi^2 = 10.94$, $df = 4$, $p < .05$). Endorsement of the viral load belief item ($\beta = 0.41$, $p < .05$) and having an undetectable viral load ($\beta = 1.43$, $p < .05$) were significantly associated with insertive UAI with HIV-negative partners or partners of unknown status.

Model 2 statistically predicted receptive UAI with HIV-negative partners or partners of unknown status ($\chi^2 = 6.05$, $df = 5$, $p < .05$). Endorsement of the viral load belief item ($\beta = .40$, $p < .05$) was significantly associated with receptive UAI with HIV-negative partners or partners of unknown status. Endorsement of sexual positioning belief was not associated with receptive UAI with HIV-negative partners or partners of unknown status.

Model 3 statistically predicted insertive UAI with HIV-positive partners ($\chi^2 = 11.68$, $df = 5$, $p < .05$). Endorsement of a belief in serosorting ($\beta = .53$, $p < .05$) was significantly associated with insertive UAI with HIV-positive partners.

Model 4 statistically predicted receptive UAI with HIV-positive partners ($\chi^2 = 24.88$, $df = 6$, $p < .001$). Serosorting belief ($\beta = .88$, $p < .01$), viral load belief ($\beta = .74$, $p < .01$), and being in a long-term relationship ($\beta = 1.45$, $p < .05$) were significantly associated with receptive UAI with HIV-positive partners.

Discussion

To our knowledge, this is the first study to assess the possible influence of beliefs regarding viral load and

Table 4 Logistic regression models

	df	Est.	S.E.	X^2	p	OR	95% CI	
							Upper	Lower
Model 1: Insertive UAI with HIV-negative partner or partner of unknown status ($n = 129$)								
Parameter								
Viral load belief	1	0.41	0.19	4.33	<0.05	1.45	1.02	2.18
Undetectable viral load	1	1.43	0.68	4.49	<0.05	4.18	1.11	15.70
Model 2: Receptive UAI with HIV-negative partner or partner of unknown status ($n = 129$)								
Parameter								
Viral load belief	1	0.40	0.18	4.63	<0.05	1.50	1.03	2.16
Model 3: Insertive UAI with HIV-positive partner ($n = 81$)								
Parameter								
Serosorting belief	1	0.53	0.25	4.53	<0.05	1.70	1.04	2.76
Model 4: Receptive UAI with HIV-positive partner ($n = 81$)								
Parameter								
Serosorting belief	1	0.88	0.29	9.40	<0.01	2.41	1.38	4.24
Viral load belief	1	0.74	0.27	7.49	<0.01	2.10	1.23	3.56
In a long-term relationship	1	1.45	0.66	4.92	<0.05	4.28	1.19	15.46

Viral load belief "If my viral load is low or undetectable I am less likely to infect another person with HIV if I have unprotected sex"

Serosorting belief "I am less concerned about using condoms with a partner who is also HIV positive"

infectiousness, serosorting, and sexual positioning on UAI among YMSM living with HIV/AIDS. Proportions of UAI with HIV-negative or unknown status partners reported in this sample are somewhat higher than those reported in samples of adult MSM living with HIV/AIDS, and proportions of UAI with HIV-negative partners were somewhat lower than found in adult samples [11], and lower than overall UAI rates reported in other HIV-positive YMSM samples [23]. The consistency of rates of UAI across all four types of UAI investigated do not suggest serosorting or sexual positioning patterns in and of themselves, as each type of UAI is reported by roughly 20% of the sample.

Despite the lack of apparent serosorting patterns in the sample, regression analysis did determine a belief in serosorting to be a significant predictor of both insertive and receptive UAI with HIV-positive partners. A belief that an undetectable viral load makes one less infectious ("viral load belief") was significantly associated with all types of UAI, except for insertive UAI with HIV-positive partners. Having an undetectable viral load was significantly associated with insertive UAI with HIV-negative or status-unknown partners. Being in a long-term relationship was also significantly associated with receptive UAI with an HIV-positive partner.

We found no evidence of sexual positioning in this sample, either in terms of (1) rates of receptive UAI compared to insertive UAI or (2) a belief in sexual positioning predicting receptive UAI with any partner type. The lack of belief in sexual positioning demonstrating any statistical significance with receptive UAI may in part be due to the skewness present in the sexual positioning beliefs of participants as reported in Table 2, indicating that very few participants strongly agreed with the belief that sexual positioning makes it difficult for HIV-positive men to sexually transmit HIV.

The regression results regarding belief that a low or undetectable viral load beliefs makes one less infectious are somewhat confounded by the lack of significant associations among the treatment-related control variables with most of the UAI dependent variables—the exception being the significant association between having an undetectable viral load and engaging in insertive UAI with HIV-negative or unknown status partners. Despite the participants in the study being recruited from adolescent medicine clinical sites, there were relatively low proportions of participants that were on ART (47%), knew their CD4 count (59%), knew their viral load (39%), and that had an undetectable viral load (15%). We did not have access to actual clinical data in this study and relied on participant self-report for clinical markers, but these proportions are somewhat consistent with those reported in other recent samples of HIV-positive YMSM recruited from clinics [26].

Nonetheless, participants' lack of knowledge of their own viral load and CD4 counts has considerable implications as HIV treatment and prevention continue to evolve. "Treatment as prevention" as a population-based prevention strategy has gained currency since the advent of ART [27, 28] and more recently in light of findings regarding pre-exposure prophylaxis using ART [29]. ART initiation

has historically been based on CD4 cell counts, with ART success (and, by extension, reduced infectiousness) indicated by undetectable viral load. More research is needed to determine how YMSM understand prevention and risk reduction messages regarding treatment, viral load and infectiousness, and how they understand the meanings of disease-related indicators as communicated by clinical staff.

Researchers investigating serosorting among MSM have noted that while serosorting theoretically should provide protection against HIV transmission, in practice its protective effect may be compromised by a range of factors [5, 30]. Both HIV-positive as well as HIV-negative MSM have been shown to "seroguess" a partner's HIV status at similar rates to serosorting through actual disclosure of one's status [30]. Disclosure to romantic and dating partners has been shown to be a greater challenge for HIV-positive adolescents than disclosure to family or friends [31]. Within sex-seeking contexts, disclosure appears to be facilitated among both HIV-negative and HIV-positive MSM by distal communication channels, such as online or via telephone rather than in-person [32]. Previous research has shown that disclosure among HIV-positive men varies by type of partner and tends to decrease as number of sex partners increases, and that increased likelihood of disclosure is associated with positive outcome expectations [33]. Interventions aimed at increasing rates of disclosure among HIV-positive YMSM should consider relationship, context, and communication channels when promoting disclosure as a risk reduction strategy in this population.

Disclosure among YMSM living with HIV/AIDS in order to engage in UAI may not effectively reduce health risks, as serosorting among HIV-positive MSM is compromised by risk of transmission of sexually transmitted infections [5]. There is mounting evidence from studies conducted in Europe that marked increases in sexually transmitted hepatitis C (HCV) infection among HIV-positive MSM there have occurred since the introduction of ART [34–36]. The little research conducted in North America on HCV among HIV-positive MSM has attributed most HIV/HCV co-infection to intravenous drug use [37, 38], although emerging research suggests that new HCV infection is concentrated in clusters of HIV-infected men that exhibit both drug using and sexual risk behavior [39, 40]. Given increasing prevalence of HCV co-infection among groups of MSM living with HIV/AIDS, serosorting-based decisions to engage in UAI may lead to continued increases in hepatitis C co-infection among this population [41]. There are serious consequences for treatment of HIV and HCV co-infection, with increased risk for hepaotoxicity for patients on ART and significant increases in liver disease mortality [42].

There are several methodological limitations inherent in the study's design. We used a convenience sample of HIV-positive YMSM currently in care, and did not utilize a probability sample, which limits generalizability; however, our sample roughly mirrors the current HIV epidemic in the U.S. among YMSM proportionally in terms of racial/ethnic groups represented.

The cross-sectional design of this study does not allow for any establishment of causality among the study's variables of interest. All data in the study were self-reported and as such potentially subject to social desirability or recall bias, but the use of ACASI may mitigate the perceived need to report socially desirable answers to potentially stigmatizing questions.

Additionally, our use of single item predictors has the potential to reduce the validity of our findings. Development and testing of scales measuring risk reduction beliefs among persons living with HIV/AIDS will have significant implications as treatment and prevention become even more closely linked. A further potential limitation of our study lay in how we classified unknown status partners. Questions assessing UAI asked participants to recollect numbers acts of UAI with partners that were HIV negative or of unknown status, thereby combining the two groups. Other research that has assessed UAI with partners of unknown status separately has emphasized the role of disclosure among MSM [43], whereas we included partners of unknown status with HIV-negative partners from a risk-of-HIV-transmission perspective. Further, we did not distinguish between regular and casual sex partners when asking about participants' UAI. Although relationship status was shown in our analysis to have a significant association with receptive UAI with HIV-positive partners, assessing participants' UAI separately with regular and casual partners might have revealed other important differences by UAI and partner type. Our findings are also limited in that we did not collect data on number of partners for each type of UAI, and as such we cannot describe how the different types of UAI may vary as a function of number of partners.

This study advances our knowledge of sexual risk behavior and risk reduction beliefs among YMSM living with HIV/AIDS. The influence of serosorting and viral load beliefs should be assessed in future secondary prevention and risk reduction efforts with this population. As the HIV epidemic in the U.S. continues to disproportionately affect YMSM, more research is needed to further disentangle the influence of risk reduction beliefs on UAI within the context of evolving ART and biomedical prevention technologies, disclosure of HIV status, the understanding of clinical indicators among HIV-positive YMSM, and hepatitis C and other sexually transmitted infections.

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