

HIV Transmission Risk among HIV Seroconcordant and Serodiscordant Couples: Dyadic Processes of Partner Selection

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Abstract Selecting sex partners of the same HIV status or serosorting is a sexual risk reduction strategy used by many men who have sex with men. However, the effectiveness of serosorting for protection against HIV is potentially limited. We sought to examine how men perceive the protective benefits of factors related to serosorting including beliefs about engaging in serosorting, sexual communication, and perceptions of risk for HIV. Participants were 94 HIV negative seroconcordant (same HIV status) couples, 20 HIV serodiscordant (discrepant HIV status) couples, and 13 HIV positive seroconcordant (same HIV status) couples recruited from a large gay pride festival in the southeastern US. To account for nonindependence found in the couple-level data, we used multilevel modeling which includes dyad in the analysis. Findings demonstrated that participants in seroconcordant relationships were more likely to believe that serosorting reduces concerns for condom use. HIV negative participants in seroconcordant relationships viewed themselves at relatively low risk for HIV transmission even though monogamy within relationships and HIV testing were infrequent. Dyadic analyses demonstrated that partners have a substantial effect on an individual's beliefs and number of unprotected sex partners. We conclude that relationship partners are an important source of influence and, thus, intervening with partners is necessary to reduce HIV transmission risks.

Keywords HIV · Serosorting · MSM · Dyad · Multilevel modeling

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Introduction

Nearly all HIV infections now occur in the context of dyadic relationships (CDC 2007). Yet, analyses of HIV transmission-related behaviors typically focus on just one individual in the relationship and ignore the individual's relationship partner. Given the inherent dyadic nature of most HIV transmissions, it is essential to consider risk behaviors not only in terms of the individual but the partner and dyad as well.

Serosorting is one process related to HIV transmission that occurs at the level of the dyad. Serosorting is a partner selection strategy whereby sexual partners are chosen on the basis of their HIV status. Serosorting refers to choosing same HIV status partners for both condom protected and unprotected sexual acts and also for having only unprotected sexual acts with same HIV status partners (CDC 2004; Patel et al. 2006; Scott 2007; Suarez et al. 2001). However, from a public health standpoint, concerns toward serosorting revolve mainly around its use for selecting unprotected sexual partners. Studies of men who have sex with men (MSM) have identified serosorting unprotected sexual partners as a common means for preventing HIV transmission (Eaton et al. 2007; Xia et al. 2006a). For many men, serosorting is believed to make HIV transmission less likely and condom use unnecessary. Therefore, knowledge of partner HIV serostatus can be a determining factor in sexual risk decision making (Bouhnik et al. 2007; Lightfoot et al. 2005).

Although serosorting is considered by some MSM to be an effective HIV prevention strategy, there are several factors that counter this assumption (Mao et al. 2006; Xia et al. 2006a). For uninfected persons, the effectiveness of serosorting relies on accurate and open HIV status disclosure. However, a combination of factors, including lag

between HIV tests and failure to openly discuss HIV status, can affect the accuracy of a sex partner's reports of his HIV status (Jin et al. 2007). Furthermore, HIV testing is not universal among MSM (Do et al. 2005; Manning et al. 2007; Xia et al. 2006b). Infrequent HIV testing and continued unprotected sex practices decrease the likelihood of accurately knowing one's own HIV status as well as the HIV status of one's sexual partners. Moreover, recently HIV infected individuals often test HIV antibody negative, making individuals who are at elevated risk for HIV transmission unaware of their HIV infection status (Pilcher et al. 2006).

Despite increases in risk behaviors among MSM in some cities, a stabilization of HIV incidence may be partly attributable to serosorting. In terms of preventing HIV infections, some data suggests that through serosorting HIV infections have been reduced (Truong et al. 2006). However, it has been shown that serosorting may not only offer little protection from HIV, but may increase overall HIV transmission rates. Modeling has demonstrated that the risk of HIV transmission from an acutely infected HIV antibody negative person is 82 in 10,000 acts, whereas sex with an HIV positive off treatment person is 7 in 10,000, HIV positive on treatment person is 1 in 10,000, and HIV positive person with advanced HIV disease is 36 in 10,000 acts (Butler and Smith 2007). The elevated infectiousness associated with acutely infected persons, who can potentially test HIV negative, is a major obstacle prohibiting serosorting from being an effective HIV prevention strategy.

For HIV positive individuals who serosort, there are risks associated with unprotected sex. HIV positive seroconcordant couples do risk exposure to coinfection with other sexually transmitted infections (STI), which can complicate and accelerate HIV disease. Repeated exposure to ejaculate during unprotected anal intercourse is associated with CD4 cell decline, most likely due to STI coinfection (Wiley et al. 2000). Syphilis and other genital ulcer diseases have also been linked to decreased CD4 cells and increased blood and genital secretions viral load (Buchacz et al. 2004; Dyer et al. 1998; Kalichman et al. 2007a). Additionally, reinfection with other variants of HIV, including drug-resistant viral strains, has been of concern for HIV positive persons (Smith, Richman, & Little 2005). Thus, there exists risks when serosorting for men who are HIV positive.

Given the prevalence of serosorting among MSM, understanding why both HIV positive and HIV negative men engage in this practice requires an understanding of their beliefs about serosorting. Individuals who serosort most likely believe that they are actively taking steps to reduce their HIV infection risks (Eaton et al. 2007). Additionally, the rationale behind serosorting may negate

concerns about having to use condoms for HIV prevention. By openly disclosing or assuming same HIV status among sexual partners, MSM may believe they are protecting themselves from HIV and justify not engaging in safer sex discussions during sexual acts. Consequently, serosorting can cause men to believe they are protecting themselves and their sex partners from HIV even when they are engaging in high risk sexual behavior.

In theory and in practice, beliefs about serosorting should also be related to perceptions of risk. For men who engage in serosorting, they likely hold the perception that by limiting their sexual partners to those of the same HIV status they are lowering their risk of HIV infection. Studies have demonstrated that risk perceptions have an important role in predicting health-related behavior (Azzarello et al. 2005; Ellen et al. 2002; Hampson et al. 2000). Theories of perceived risk suggest that individuals construct their perceptions of risk as a means of justifying continued risk practices (Gerrard et al. 1996). From this perspective, one's risk taking is likely shaped by behaviors that are believed to be risk reducing, such as selecting partners who are believed to be of the same HIV status. Hence, perceptions of risk for HIV transmission can inform sexual risk decision making.

In the current study, we sought to examine serosorting beliefs, sexual communication beliefs, and perceptions of risk among male couples or dyads. This paper is among the first to examine HIV risks in same HIV status (seroconcordant) and different HIV status (serodiscordant) couples at the dyad level. By incorporating partner effects in the analysis we can begin to address the degree to which individuals influence or are influenced by their partner's beliefs and perceptions. Analyzing couple's data at the dyad level takes into account the effect of the partner on an individual's responses and, thus, the reciprocity of influence that occurs within couples. Furthermore, dyadic influences are not limited to factors occurring within a relationship; for example, dyadic influences can have an effect on factors occurring outside of the dyad, such as, whether or not an individual has multiple other partners outside of their relationship.

The key features of dyad-level data analysis are that partner, dyad, and respondent variables are used to predict the outcome. In this case, respondent is the individual providing the data and partner is the other member in the relationship. By including these three factors, the nonindependence of the two persons' responses is measured and controlled (Kenny 1996). Nonindependence is defined as follows: the data from two members who are in a relationship with each other are more likely to be similar (or different) than data from two members who are not in a relationship with each other. Ignoring nonindependence of data by treating the individual as the unit of analysis biases

estimates of standard errors of effects and can at times increase Type I errors and other times increase Type II errors. The necessity of accounting for nonindependence in the data warrants the use of dyadic data analysis (Kenny et al. 2006).

We hypothesized that, compared to men who are in serodiscordant relationships, men who are in seroconcordant relationships will: (a) more strongly endorse serosorting beliefs, (b) report greater limitations of discussing safer sex behaviors, and (c) report lower perceived risk for HIV. Moreover, we predicted that respondent, partner, and dyad level findings will contribute information about serosorting beliefs, sexual communication beliefs, perceptions of risk, and risk behavior beyond what would be garnered from individual data alone.

Method

Participants and Setting

Surveys were collected using venue intercept procedures that have been previously reported (Halkitis and Zade 2004; Kalichman et al. 2007b; Kalichman 1998; Vanable et al. 2000). Potential participants were asked to complete a survey concerning same-sex relationships as they walked through the exhibit and display area of a large gay community festival in Atlanta, GA, where two booths were rented for the purpose of this study. Participants were told that the survey was about same-sex relationships, contained personal questions asking about their behavior, was anonymous, and would take 15 min to complete. No demographic data was collected on participants who declined to respond to the survey.

Participants were asked if they were attending the festival with a relationship partner. If they were with their partner, the partner was asked if he would complete the survey as well. In order to code participants who were in a relationship, the time of the survey and staff initials were recorded on each of the two surveys, allowing us to link couples' surveys. After surveys were coded, staff stressed to the participants the importance of confidentiality, such that completing the survey without discussing any of their responses with their partner was necessary.

Participants' names were not obtained at any time. Participants were offered \$4 for completing the survey and were given the option of donating their incentive payment to a local AIDS service organization. Approximately 80% of men approached agreed to complete the survey. Participants were 801 men surveyed during June of 2006. Of these men, 254 were in a relationship, both partners took a survey, and thus their responses were included in the data analyses.

Measures

Participants completed self-administered anonymous surveys measuring: demographic characteristics, serosorting beliefs, sexual communication beliefs, perception of HIV transmission risk, and number of unprotected sexual partners.

Demographic Characteristics

Participants were asked their age, years of education, income, ethnicity, whether they identify as gay, bisexual, or heterosexual, if they were in a relationship, how "out" they are about their sexual orientation, whether they had been tested for HIV, the date they were last tested, and their last HIV test result. Finally, participants were asked to report how long they had been in a relationship with their partner.

Serosorting Beliefs

To assess serosorting beliefs, participants were asked to complete two single-item questions: (1) If my partner tells me his HIV status is the same as mine, I am more likely to have unprotected sex with him, and (2) If my partner tells me his HIV status is the same as mine, then I worry less about HIV. Responses to the questions were based on a 6-point Likert scale (1 = *Strongly Disagree*, 6 = *Strongly Agree*).

Sexual Communication Beliefs

Three items were used to assess participants' beliefs regarding sexual communication for risk reduction. Specifically, beliefs about the importance of talking to one's sexual partners about risk and risk reduction were asked. The following single item questions were used: (1) If I suggest using condoms my partner will think I have an STD or HIV, (2) I am comfortable telling my sex partners my HIV status before having sex, and (3) I would not feel confident suggesting using condoms with a new partner. Responses to these questions were on a 6-point Likert scale (1 = *Strongly Disagree*, 6 = *Strongly Agree*).

Perception of HIV Transmission Risk

In order to assess perceptions of HIV transmission risk, we asked participants to mark along a visual analogue scale (VAS; Kalichman et al. 2005) their perception of their risk for HIV infection or reinfection. Specifically, the question asked, "Think about your sex behaviors from the past 6 months, since the end of January. Based on your sex behaviors from the past 6 months, how much risk do you believe you are at for getting HIV or infecting someone with HIV? Mark a line showing how much risk you are at."

The VAS consisted of a grayscale gradient on which participants marked their responses. The VAS was anchored by “No Risk, Abstinent, Not Having Sex At All” to “Extremely High Risk, Having Anal Sex Without A Condom To Ejaculation When The Top Partner is HIV Positive.” Participants were instructed to answer anywhere along the 248 mm continuum, marking a line wherever it best represented their perception of HIV risk.

Sex Partners

Because HIV risks conferred within and outside of established sexual relationships are best defined by the number of unprotected sex partners (Catania et al. 2005), participants were asked to report the number of HIV negative and HIV positive sex partners with whom they engaged in sexual behaviors in the past 6 months. Specifically, we asked participants to report numbers of partners with whom they had done the following sex acts with: “Anal sex, no condom used, my partner inserted his penis in me,” “Anal sex, no condom used, I inserted my penis in my partner.” Overall number of sexual partners was also asked. This question was used to define monogamous relationships; couples in which neither partner had outside sex partners in the past 6 months. In addition, only relationships of 6 months duration or longer were included in the analysis of monogamy ($N = 60$ couples).

Data Analyses

Data were screened based on the following criteria: Participants who identified themselves as heterosexual ($n = 38$, 4.7%), or not involved in a relationship or not having a partner who completed the survey ($n = 509$, 64%) were removed from further analyses. In total, 254 (32%) participants were included in the study.

The final sample was composed of three types of couples: both members of the dyad were HIV negative (188 men in 94 HIV negative seroconcordant relationships), both members were HIV positive (26 men in 13 HIV positive seroconcordant relationships), and one member was HIV positive and one member was HIV negative (40 men in 20 HIV serodiscordant relationships). Given these three dyad types, there were then four types of individuals. We refer to the individual providing the data as the respondent, and the partner of this person as the partner. The four types of dyads were: HIV positive respondent with HIV positive partner (Positive–Positive), HIV positive respondent with HIV negative partner (Positive–Negative), HIV negative respondent with HIV positive partner (Negative–Positive), and HIV negative respondent with HIV negative partner (Negative–Negative). With four groups, three effects can be estimated. These three effects in our

analyses were respondent HIV status, partner HIV status, and the respondent HIV status by partner HIV status interaction, i.e., dyad HIV status. In the current study, both respondent HIV status and partner HIV status vary between and within dyads. That is, some dyads contain an HIV positive and HIV negative person, some contain two HIV positive persons, and some contain two HIV negative persons. Thus, HIV status of partners is referred to as a mixed variable (Kenny et al. 2006).

We used the Actor-Partner Interdependence Model (APIM) as the statistical framework for data analysis (West et al. 2008). Data were organized in a pairwise manner; as such, individual records were created, but the data for the respondent and his partner were included together in the same case. The APIM (Campbell and Kashy 2002; Kenny and Cook 1999; Kashy and Kenny 2000) is a data-analytic approach that simultaneously estimates the effect that a respondent HIV status has on his own outcome score (respondent effect) and the effect of the respondent’s partner’s HIV status on the respondent’s outcome score (partner effect). In addition we examined the interaction between the respondent’s HIV status and the partner’s HIV status (dyad HIV status) on the respondent’s outcome score. These analyses controlled for correlations between the two respondents, i.e. controlled for nonindependence in the data.

All APIM models were estimated and tested using multilevel modeling. For all analyses, HIV negative participants were coded as -1 , and HIV positive participants were coded as 1 . For these models, the interaction of respondent’s HIV status and partner’s HIV status represents both partners who serosort and partners who do not (i.e., HIV negative seroconcordant partners are mathematically represented by $-1 \times -1 = 1$; HIV positive seroconcordant partners as $1 \times 1 = 1$; and HIV serodiscordant partners as $-1 \times 1 = -1$). For each of the main outcome variables (serosorting and sexual communication beliefs, HIV risk perception, and number of sexual partners) data missing were less than 3%: 127 couples were included in the APIM analyses.

Results

As seen in Table 1, HIV negative participants who were in a relationship with an HIV negative individual were younger than other participants, while HIV positive participants tended to be older. Educational attainment was similar among all participants with some college being the average level of education. Income was similar across all participants. Specifically for HIV positive respondents, they were more likely to be African-American. Overall, HIV positive participants were less likely to be employed than HIV

Table 1 Demographic characteristics of individual respondents in HIV seroconcordant and discordant relationships

	HIV negative respondent HIV negative partner (<i>n</i> = 188)		HIV negative respondent HIV positive partner (<i>n</i> = 20)		HIV positive respondent HIV negative partner (<i>n</i> = 20)		HIV positive respondent HIV positive partner (<i>n</i> = 26)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age	34.0	10.3	39.6	11.8	38.8	7.9	40.0	8.5
Education	14.9	2.1	14.8	2.1	14.0	2.2	14.3	2.0
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Income								
\$0–15,000	20	11	1	5	4	21	4	16
\$16–30,000	41	23	2	10	3	16	7	28
\$31–45,000	45	25	6	30	5	26	4	16
≥\$46,000	75	41	11	55	7	37	10	40
Ethnicity								
White	148	80	17	85	13	65	13	52
African-American	18	10	3	15	6	15	11	44
Hispanic/Latino	12	7	0	0	1	5	0	0
Asian-American	5	3	0	0	0	0	0	0
Other	4	2	0	0	0	0	1	4
Employment								
Working	157	86	18	90	12	60	18	72
Not working	28	15	2	10	8	40	7	28
How out								
Definitely closeted	2	1.2	1	7	1	6.3	0	0
Closeted some of the time	43	27	4	27	5	31	2	9.1
Definitely out	116	72	10	67	10	63	20	91

Table 2 HIV testing and partner characteristics among individual respondents in HIV seroconcordant and discordant relationships

	HIV negative respondent HIV negative partner (<i>n</i> = 188)		HIV negative respondent HIV positive partner (<i>n</i> = 20)		HIV positive respondent HIV negative partner (<i>n</i> = 20)		HIV positive respondent HIV positive partner (<i>n</i> = 26)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Last time respondent had HIV test (months)	17.3	28.7	14.0	18.7	87.1	95.2	63.6	79.0
Relationship length (years)	3.8	5.1	0.5	0.5	0.5	0.5	4.8	6.3
Number of sex partners in past 6 months	2.7	5.0	2.9	6.7	3.8	8.9	5.7	9.5
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Both respondent and his partner are monogamous ^a	21	21	3	33	3	38	0	0

^a Only relationships lasting 6 months or longer were included for this variable

negative participants. A majority of the participants were “out” about their sexual orientation. The average length of time since HIV positive diagnosis was 6.3 years.

Additionally as seen in Table 2, relationship length among participants varied; HIV negative seroconcordant relationships and HIV positive seroconcordant

relationships were longer in duration than HIV serodiscordant relationships. Number of sexual partners was highest among HIV positive respondents in seroconcordant relationships. HIV testing among HIV negative respondents was infrequent, with the average last HIV test taken over a year ago. In terms of monogamy, with the exception of HIV positive seroconcordant relationships where no monogamous relationships were reported, only about one in four relationships were monogamous (only relationships lasting 6 months or longer were included in monogamy related analyses).

APIM Analyses

We examined the effects of HIV status of respondent, partner, and dyad, on the main outcome variables using the APIM. As shown in Table 3, respondents in seroconcordant relationships were more likely to agree that they would have unprotected sex with a partner if that partner had the same HIV status as they did. This finding is evidenced by a statistically significant, positive dyad status effect estimate. For APIM analyses, estimates can be used to generate mean differences in scores. This feature of APIM is beneficial because estimates can be readily used to provide raw data on the differences in scores between groups. In this case, participants in same-status relationships scored 1.08 (dyad estimate of 0.54 multiplied by 2) points higher than mixed status relationships on this particular measure (for this measure scores ranged from 1 to 6). Moreover, the respondent effect showed that participants who were HIV positive score 0.74 points higher on this measure than men who were HIV negative. For this item there was no statistically significant partner effect. Likewise, no respondent, partner, or dyad effects emerged when analyzing differences on whether or not participants worry less about HIV when their partner is the same HIV status.

In terms of sexual communication beliefs, HIV positive respondents scored nearly a point higher than HIV negative respondents on the measure of believing that if they suggest using condoms their partner will think they have HIV/STD (scores ranged from 1 to 6). HIV negative respondents scored 0.36 points higher than HIV positive respondents on the scale measuring how comfortable they are telling their sex partners their HIV status. For this same item there was also a dyad effect; participants in seroconcordant relationships scored 0.44 points higher on the measure of being more comfortable disclosing their HIV status. Finally, HIV positive participants scored 0.68 points higher on the item asking participants if they were not confident suggesting using condoms with new partners.

HIV positive participants perceived greater risk for HIV reinfection or infection than HIV negative participants,

scoring 38.2 points higher on a 248-point scale. Likewise the partner effect demonstrated that participants, either HIV negative or HIV positive, with HIV positive partners perceive themselves to be at greater risk for HIV reinfection or infection, scoring 36.2 points higher on this scale. For this variable, there was no effect of dyad status.

As for sexual partners, because no differences emerged between being receptive or insertive partner, these variables were added together to form a composite variable. When we examined the number of HIV negative, unprotected anal sex partners reported in the past 6 months, we found no differences due to respondent, partner, or dyad. However for number of HIV positive unprotected anal sex partners, there were respondent, partner, and dyad effects. Participants who were HIV positive, in a relationship with an HIV positive person, or in a seroconcordant relationship reported more HIV positive partners. In closer examination of the data, HIV positive men in seroconcordant relationships reported a significantly greater number of HIV positive unprotected anal sex partners. This finding suggests that these men who are in a seroconcordant relationship overall report the most HIV positive partners and that the dyad effect is being driven largely by these HIV positive respondents.

There was considerable nonindependence in the data. By controlling for HIV status of the respondent and their partner, five out of the six statistically significant dyadic analyses demonstrated reduced intraclass correlation or independence (see Table 3). These findings show that nonindependence was present in the data, thus, necessitating the use of dyad as the level of analysis.

Discussion

We have found that HIV positive MSM and MSM in seroconcordant relationships were more likely to agree to unprotected sex if their partner was of the same HIV status. However, on average, concerns for HIV transmission were evident for all MSM in this study. Furthermore, HIV positive MSM were less confident about suggesting using condoms, which may be a motivation for engaging in serosorting. This finding is contrary to our initial hypotheses that men in seroconcordant relationships would report greater limitations to discussing condom use. Limitations were found among HIV positive men regardless of whether or not they were in a seroconcordant relationship. MSM who were in seroconcordant relationships or were HIV negative were more comfortable disclosing their HIV status. This finding supports the idea that HIV positive MSM may be more reluctant to disclose their HIV status especially to HIV negative MSM. We hypothesized that serosorting beliefs would be more likely endorsed by men in

Table 3 Dyadic analysis of serosorting and sexual communication beliefs: means and effect estimates

	HIV Negative Respondent Partner <i>M</i>	HIV Negative Respondent Partner <i>M</i>	HIV Positive Respondent Partner <i>M</i>	HIV Positive Respondent Partner <i>M</i>	HIV Positive Respondent Partner <i>M</i>	Respondent Estimate (SE)	Partner Estimate (SE)	Dyad Estimate (SE)	ICC ^b
Serosorting beliefs									
If my partner tells me his HIV status is the same as mine, I am more likely to have unprotected sex with him	3.09	2.55	2.76	4.38	0.37 (0.16)*	0.26 (0.16)	0.54 (0.17)**	0.07 ^c	
If my partner tells me his HIV status is the same as mine then I worry less about HIV	2.97	2.89	2.58	3.23	-0.01 (0.16)	0.14 (0.16)	0.18 (0.17)	0.03	
Sexual communication beliefs									
If I suggest using condoms my partner will think I have an STD or HIV	1.89	1.67	2.80	2.69	0.48 (.13)**	-0.08 (0.13)	0.02 (0.16)	0.26	
I am comfortable telling my sex partners my HIV status before having sex	5.71	5.19	4.89	5.27	-0.18 (.09)*	-0.03 (0.13)	0.22 (0.16)*	0.05 ^c	
I would not feel confident suggesting using condoms with a new partner	1.73	1.53	2.37	2.23	.34 (.14)*	-0.07 (.14)	0.02 (0.14)	0.02 ^c	
Risk perception									
Risk taken for HIV infection or reinfection in past 6 months	42.36	83.98	85.92	116.72	19.1 (5.8)**	18.1 (5.8)**	-2.7 (7.05)	0.28 ^c	
Sexual partners in past 6 months									
Unprotected, HIV negative, anal sex partners ^a	1.83	0.45	0.95	1.29	-0.01 (.24)	-0.25 (0.24)	0.43 (.27)	0.19	
Unprotected, HIV positive, anal sex partners ^a	0.05	0.71	0.53	7.51	1.82 (.41)***	1.91 (.41)***	1.58 (.72)**	0.98 ^c	

* $P < .05$; ** $P < .01$; *** $P < .001$

^a Due to the positive skew, this variable was initially log transformed and then analyzed. The main results of this analysis were the same when compared to untransformed analyses. Thus, we present the simpler untransformed for ease of interpretation

^b ICC is the intraclass correlation coefficient

^c Nonindependence reduced by controlling for HIV status of respondent and their partner

seroconcordant relationships; this hypothesis was supported for beliefs about serosorting and condom use but not for serosorting and HIV risk. We found that serosorting related beliefs and behaviors were predicted by partner and dyadic effects, above and beyond what would have been provided by only investigating individual-level effects. To the best of the authors' knowledge, these influences have not been reported in previous research related to HIV risk behaviors.

HIV negative participants involved in a seroconcordant relationship, on average, perceived the least amount of risk for HIV transmission. We hypothesized that men in seroconcordant relationships would perceive lower risk for HIV, however, this was not true for HIV positive men who perceived considerable risk for HIV reinfection. Interestingly, for HIV negative men, when considering the lack of monogamy in some relationships, infrequency of HIV testing (last test was reported as more than 1 year ago), and potential for undetected acute HIV infection, the risk for HIV transmission may be much higher than they perceive. HIV positive seroconcordant partners, who reported high rates of partners outside of their relationship and no monogamy, face possible risk of HIV coinfection with other STIs and HIV reinfection. Taken together, beliefs about the protective effects of serosorting appear to be misleading, likely contribute to a false sense of security, and may place individuals at higher risk for HIV infection, reinfection, and STI coinfection. Perceived risk of HIV transmission for HIV positive or HIV negative MSM in serodiscordant relationships was virtually the same. These findings suggest that regardless of participant HIV status, there is some consistency of perceptions of risk among MSM in serodiscordant relationships.

The difference in relationship length on the basis of relationship seroconcordance is also of interest. The longevity of seroconcordant relationships versus the lack of longevity of serodiscordant relationships indicates that HIV status may have considerable impact on variables related to relationship satisfaction such as, closeness, alternative relationship opportunities, and peer approval of relationship (Felmler 2001). This finding warrants further investigation with a larger sample of HIV positive seroconcordant couples. Also of importance is the finding that men who are in serodiscordant relationships report multiple sexual partners, possibly creating another dimension of risk over time. Longitudinal data are needed to further assess this finding. Moreover, distinguishing between casual and steady partners in future analyses would help in better understanding the relationship between seroconcordancy, relationship length, and risk behaviors.

In determining other factors that may influence serosorting it is important to consider a broader context. Reporting only same HIV status partners may reflect the notion that men of the same HIV status are in similar social

and sexual networks which facilitates finding partners of the same HIV status. Likewise, reporting only same HIV status partners may be indicative of use of other risk reduction strategies. Research on what are referred to as *negotiated safety* (the decision to forgo using condoms between men who are in a committed relationship and may only have outside partners if they use condoms; Guzman et al. 2005; Kippax et al. 1993) and *strategic positioning* (HIV negative men are the insertive partner and HIV positive men are the receptive partner during anal intercourse; Parsons et al. 2005) has demonstrated that MSM employ multiple strategies, outside of condom use, that may or may not reduce their risk of HIV transmission.

The current study was conducted using a convenience sample of men at a gay pride event in a southeastern US city. Due to the nature of convenience samples our findings may not be generalizable to gay/bisexual men who do not attend public gay festivals (Wegner and Fabrigar 2000). For example it is likely that our sample under-represents gay/bisexual men who are not open enough about their sexual orientation to attend such an event. The men included in our study were in relationships, thus, our findings may not be applicable to men without partners. Moreover, social and cultural aspects specific to homosexuality in the southern US should be considered when interpreting our findings. Conservative beliefs towards class, race, and gender; and an emphasis on relationships to home and family all serve as strong forces in shaping sexual identities of people living in the South (Sears 1991). Therefore, limitations of our sample caution against overgeneralizing our findings to broader populations of gay/bisexual men, and our study findings require replication with samples drawn from different geographical regions.

Our study used a cross-sectional survey method, precluding any inferences of causation regarding HIV serostatus, perceptions of HIV transmission risk, sexual risk beliefs, and sex partners. Moreover, the study measures relied on self-report of sensitive and often stigmatized experiences and behaviors. Self-report of sensitive information is prone to cognitive and motivational processes that can bias responses. In particular, emotional and personal events, such as risky sexual behavior are susceptible to social biases (Reis and Gable 2000). Recency of event and state of mind during an event are other factors that bias self report data. The significant rates of sexual partners reported by this sample may therefore actually be underestimates of risk behaviors. Nevertheless, surveys such as the one reported here can yield biased information and such biases must be considered when interpreting our study findings.

Our sexual risk measures posed limitations. We assessed the number of unprotected sex partners rather than frequencies of sexual acts because our study focused on

serosorting. This approach allowed us to estimate unprotected sex partners but did not allow for estimating frequencies of potential exposure to HIV. Alternatively, we could have assessed frequencies of sexual acts. Sexual acts outside of the index relationship would have required a partner-by-partner assessment methodology which is difficult to achieve in a self-administered anonymous survey. From a measurement perspective, number of sexual acts is necessary to estimate potential exposure (Schroder et al. 2003), whereas numbers of sex partners allows estimating risks for HIV transmission at the partner level, in keeping with partner selection strategies (Catania et al. 2005). Major limitations for number of sexual acts include not specifying if all acts are with one partner and poorer recall, while limitations of number of partners include not having a measure of the number of potential exposures within partners. Given that the aim of the study was a focus on serosorting sex partners, number of partners with whom participants engaged in sexual acts was most consistent with our goals.

Measures used in the survey lack psychometric testing and would benefit from reliability and validity testing. Furthermore, studies recruiting a larger number of both HIV serodiscordant and HIV positive seroconcordant couples are needed to further test findings from this study. Likewise, unequal sample sizes found in this study reduce statistical power and, therefore, may yield more conservative estimates than what would be found if sample sizes were equal. However, unequal cell sizes do not bias means. Even though we did find statistically significant results, our data requires replication with samples of more even cell sizes to increase power. With these limitations in mind, we believe that the current study findings offer new information about HIV risks posed to MSM in relationships.

Interventions that target and recruit couples are emerging and provide important benefits in addition to what is gained from individual level focused interventions (El-Bassel et al. 2003; Remien et al. 2005). Dyadic level analysis of these interventions is an important component and could potentially facilitate our understanding of study findings. In terms of couple's interventions for MSM, we believe that HIV prevention interventions can capitalize on the protective motivations that lead men to serosort. For example, understanding how men perceive serosorting may help inform our understanding of how men recognize and manage sexual risk reduction. Furthermore, addressing other perceived HIV prevention strategies is necessary in discussions about serosorting. Interventions that specifically address the realities of partner selection strategies, particularly serosorting, as an HIV prevention strategy for MSM are urgently needed.

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