Actor–Partner Effects of Demographic and Relationship Factors Associated with HIV Risk Within Gay Male Couples

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Abstract Recent research has investigated the association of relationship factors and dynamics with sexual behaviors and HIV risk among gay male couples. However, few studies with gay male couples have used the Actor–Partner Interdependence Model framework to examine whether factors influence an individual and his partner’s sexual risk behaviors. None of these studies analyzed whether relationship factors had influenced the sexual risk behaviors of both partners within the couple. Our cross-sectional study used dyadic data from 142 gay male couples to assess actor–partner effects of relationship commitment, trust, and investment in one’s sexual agreement for HIV risk. Multilevel modeling was used to examine which actor–partner effects of these factors were predictive of individuals and their partners having had UAI within and outside the relationship. Results indicated that participants’ likelihood of having had UAI within and outside of the relationship significantly decreased with: (1) actor effects of value in and commitment to a sexual agreement, and quality of alternatives to the relationship and (2) partner effects of participant’s age, dependability of trust, quality of alternatives to the relationship, and investment of relationship commitment. No significant actor–partner effects were detected for having had UAI within the relationship. Our findings suggest that future HIV prevention strategies should take into account how relationship factors influence an individual and his main partners’ sexual risk behaviors and in turn,

the couple’s risk for HIV. However, more research is needed to examine how actor–partner effects of relationship factors influence a variety of sexual risk behaviors within gay male couples.

Keywords Actor–partner effects · Gay male couples · HIV risk · Relationship factors · UAI

Introduction

HIV infections among men who have sex with men (MSM) continue to increase in the United States (CDC, 2011). Research studies estimate that 68 % of new HIV infections can be attributed to MSM engaging in unprotected anal intercourse (UAI) with their main sex partners (Sullivan, Salazar, Buchbinder, & Sanchez, 2009). Because UAI is the primary risk factor for HIV transmission in MSM (Coates, 2008), most research has focused on individual-level factors as predictors of sexual risk behavior. However, previous research with MSM couples has suggested relationship factors may help explain why more MSM contract HIV in the context of a same-sex relationship.

Men in same-sex relationships have UAI with their main partners for a variety of reasons and include: showing their love, building trust, and being more intimate with one another (Appleby, Miller, & Rothspan, 1999; Blais, 2006; Davidovich, de Wit, & Stroebe, 2004; de Vroome, Stroebe, Sandfort, de Wit, & Van Griensven, 2000; McLean et al., 1994; McNeal, 1997; Worth, Reid, & McMillan, 2002); strengthening their relationship commitment and satisfaction (Davidovich, de Wit, & Stroebe, 2006; de Vroome et al., 2000; McLean et al., 1994; McNeal, 1997; Worth et al., 2002); establishing a sexual agreement to allow anal intercourse without the use of condoms (Hoff & Bougher, 2008). Among gay male couples, a sexual agreement can be thought of as a “contact” that determines which sexual behaviors are allowed to occur within the relationship and if relevant,

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with any outside sex partners. Other relationship factors that are associated with an increase in HIV risk among gay male couples include relationship status or partner types (Appleby et al., 1999; Crawford et al., 2003; Davidovich, de Wit, & Stroebe, 2000; de Vroome et al., 2000; LaSala, 2004a, b; McLean et al., 1994; Prestage et al., 2006, 2008), broken sexual agreements (Davidovich et al., 2000, 2001, 2004; Elford, Bolding, Maguire, & Sherr, 1999; Hoff & Beougher, 2008; Hoff et al., 2009; Kippax et al., 2003; Xiridou, Geskus, de Wit, Coutinho, & Kretzschmar, 2003), and not knowing or assuming a partner's HIV status is negative (Davidovich et al., 2000, 2004; Elford et al., 1999). Although previous research has identified some of the contributing factors associated with UAI and HIV risk among gay male couples, more research is needed to examine how the dynamics of relationship factors affect their risk for acquiring HIV.

Sex is dynamic and interdependent because it requires the participation of both individuals. The Theory of Interdependence suggests that behaviors among dyads are interdependent because each member has a certain amount of control and influence on the outcome in the behavioral interaction that they have together (Kelley & Thibaut, 1978). This outcome depends on each member's option, value and assessment of the particular behavior and whether that behavior is important to their relationship. Further, the nature and lifespan of the interdependent relationship is based on the constant evaluation of the rewards and costs gained from the lifespan of these behavioral interactions (Kelley & Thibaut, 1978). Thus, the interactions and behaviors among interpersonal dyads are interdependent in nature because the participation from each dyad member is required in order for those interactions and behaviors to occur.

For gay male couples, the decision to have UAI is interdependent and relies upon the influences and actions of both men in the relationship. Similarly, some common relationship factors, such as trust, commitment to the relationship, and investment in a sexual agreement, also require the involvement of both men within the couple. Each of these relationship factors is based on the individual's assessment and perception of that factor toward his partner with regards to their relationship. For instance, the interactions and experiences that an individual has with his main partner (and conversely) will directly influence whether the individual is committed to being in the relationship with his main partner. Moreover, each of these constructs pertains to a dimension in the relationship that by virtue cannot exist without the involvement of both men within the gay couple. Despite the interdependent nature of UAI and relationship factors within gay male relationships, little is known on the extent to which an individual's level of commitment to the relationship, trust, and investment in a sexual agreement influences his own and his partner's engagement of UAI within or outside of the relationship (i.e., with casual partners).

The Actor–Partner Interdependence Model (APIM) provides an analytical framework to detect these influences, otherwise known as actor–partner effects (Kashy & Kenny, 2000; Kenny,

Kashy, & Cook, 2006). An actor effect measures the association of a person's score on the predictor to his own score on the outcome. A partner effect measures how each respondent's partner's score on the predictor is related to his score on the outcome. Thereby, an actor effect measures the association of a person's score on the predictor to his own score on the outcome whereas the partner effect measures the association of a person's partner's score on the predictor to his own (i.e., the actor's) outcome. Figure 1 illustrates the APIM pathway for an actor–partner effect of a predictor variable on an outcome variable.

Prior research with gay male couples has found that actor–partner effects of social support (Darbes, Chakravarty, Beougher, Neilands, & Hoff, 2011; Darbes & Lewis, 2005; Fergus, Lewis, Darbes, & Kral, 2008), processes used to select casual/secondary sex partners (i.e., serosorting beliefs) (Eaton, West, Kenny, & Kalichman, 2009), and gay community integration (Fergus, Lewis, Darbes, & Butterfield, 2005; Fergus et al., 2008) did influence sexual risk behaviors and therefore, HIV risk. However, research has yet to be studied on whether actor–partner effects of common relationship factors of trust, relationship commitment, and investment in one's sexual agreement affect HIV risk among gay male couples. Examining actor–partner effects of these common relationship factors may help us better understand how couple-level influences are associated with UAI that occurs both within and outside of the relationship, and therefore, HIV risk among gay male couples.

Using the Theory of Interdependence (Kelley & Thibaut, 1978) as a theoretical framework paired with the APIM (Kashy & Kenny, 2000; Kenny et al., 2006), we assessed whether an individual's reported demographics, trust level (Rempel, Holmes, & Zanna, 1985), commitment to the relationship (Le & Agnew, 2003; Rusbult, 1980), and investment in the sexual agreement (Neilands, Chakravarty, Darbes, Beougher, & Hoff, 2009) influenced his own practice of UAI as well as his partner's practice of UAI. Couple-level characteristics, including relationship duration, age difference within the couple, race of the couple, type of relationship, and couple's concordance about the establishment of a sexual agreement, were also assessed for actor–partner

Fig. 1 APIM framework. *Note.* Parallel lines represent actor effects, diagonal lines represent partner effects, X1 and Y1 as actor's predictor and outcome scores, and X2 and Y2 as partner's predictor and outcome scores

effects of UAI. Two outcome measures were included for the present study: UAI with the main partner, and UAI with both the main partner and a casual partner during the same timeframe. We used dyadic data from 142 gay male couples to perform a series of multilevel modeling (MLM) analyses to assess actor–partner effects for HIV risk, namely UAI.

Method

Participants

In this cross-sectional study, we collected dyadic data from 142 gay male couples who self-reported not having HIV, were English-speaking, had been together 3 months or longer, were at least 18 years of age, and self-reported having anal intercourse within the previous 3 months. To be eligible for the original study, men in the couple could have had UAI with their main partner, a casual partner, or both types of partners within the previous 3 months. A variety of recruitment methods were used to recruit male couples who lived in Portland, Oregon and Seattle, Washington between June and November 2009. Eligibility criteria were listed on all recruitment materials for the study. Both men in interested couples were informally screened when they contacted the study team to make an appointment to complete the anonymous, electronic questionnaire.

Procedure

At the pre-arranged appointment, each qualified male in every couple was directed to a laptop to read the electronic consent form and complete the 15–25 min self-administered, anonymous, electronic survey simultaneously, yet independently. Steps were taken to verify the relationship and protect the anonymity of participants' responses to the survey. We verified the relationship of each couple by comparing responses to the measures of relationship duration and living with the main partner within each couple. Responses that concurred between both men within the couple were used to verify the relationship. Of note, one couple had discrepant reports about their relationship duration (i.e., 6–12 months vs. 5–10 years). Also, personal identifying information was not collected in order to help decrease measurement error and participation bias (Catania, Gibson, Chitwood, & Coates, 1990).

Measures

Outcome Variables

To better understand HIV risk among gay male couples, we used two outcome variables to assess participants' engagement of UAI within and outside of their relationship: UAI with the main partner and UAI with both the main partner and a casual partner.

Two dichotomous measures with “yes” and “no” response options were used to assess whether participants had had UAI with their main partner, and/or with a casual partner within the previous 3 months. Based on these responses, we then created a binary, dummy variable for our second outcome measure. This outcome variable categorized participants who had UAI with *both* their main partner and a casual partner in the previous 3 months versus men who did not have UAI with both their main partner and a casual partner.

Independent Variables

Participants' demographic and relationship characteristics have previously been described in detail and reported elsewhere (Mitchell, Harvey, Champeau, Moskowitz, & Seal, 2011; Mitchell, Harvey, Champeau, & Seal, 2012). In sum, the mean age of the couple and participant was 34.1 years (SD 7.6 and 8.4, respectively). Most men self-reported as: gay (95 %); Caucasian (85 %); HIV-negative (95 %); having had UAI with their main partner (90 %); living with their main partner (82 %). About 10 % of the men ($N = 28$) self-reported that they had UAI with a casual partner whereas 8 % of the men ($N = 23$) had UAI with both their main partner and a casual partner within the previous 3 months. Additional characteristics, including age difference within the couple, race of the couple, relationship duration, type of relationship, and couple's concordance about the establishment of a sexual agreement are provided in Table 1.

Validated measures were used to assess the relationship factors of interest, including relationship commitment (Le & Agnew, 2003; Rusbult, 1980), trust (Rempel et al., 1985), and investment in one's sexual agreement (Neilands et al., 2009). The Investment Model was used to examine participants' level of relationship commitment with their main partner (Le & Agnew, 2003; Rusbult, 1980). The 22-item validated scale consisted of four constructs. Commitment level assessed long-term orientation toward the partnership, intention to remain in a relationship, and psychological attachment to a partner (seven items, $\alpha = 0.78$) (Arriaga & Agnew, 2001; Le & Agnew, 2003; Rusbult & Buunk, 1993). Satisfaction level assessed, in a comparative fashion, the negative and positive outcomes of the relationship (five items, $\alpha = 0.87$). Quality of alternatives assessed the perception that being single or an attractive alternative partner existed outside of the main relationship, and that this alternative would provide superior outcomes when compared to the current relationship (five items, $\alpha = 0.75$) (Le & Agnew, 2003). Investment size assessed the existence of concrete or tangible resources in the relationship that would be lost or greatly reduced if the relationship ended (five items, $\alpha = 0.71$) (Le & Agnew, 2003). The combination of satisfaction level, quality of alternatives, and investment size were an index of the level of commitment existing in interpersonal relationships and in turn, the probability that the relationship will persist (Rusbult, Martz, & Agnew, 1998). Responses to each item were based on a 7-point Likert-type scale (0 = Do Not Agree at

Table 1 Selected demographic characteristics of 142 gay male couples

Characteristic	% (N = 142)
Age difference within the couple ^a	
5 years and less	67 (95)
Greater than 5 years	33 (47)
Race	
Interracial couple ^b	29 (41)
Non-interracial couple ^b	71 (101)
Relationship duration ^c	
3–6 months	10 (14)
6–12 months	10 (14)
1–2 years	15 (22)
2–5 years	23 (33)
5–10 years	26 (37)
>10 years	15 (21)
Type of relationship	
Strictly monogamous	51 (72)
Open to some degree	49 (70)
Establishment of a sexual agreement ^d	
Concurrence: yes	48 (68)
Concurrence: no	16 (23)
Non-concurrence	36 (51)

^a Age difference within the couple was defined as the difference in age between the two men within the male couple

^b Interracial couple was defined as any male couple who had one male self-reporting a different race than his partner (i.e., Asian and African American, White and Mixed, etc.). Non-interracial couple was defined as any male couple with both men self-reporting the same race

^c Data for relationship duration represents 141 male couples; 1 couple had discrepant reports (i.e., 6–12 months vs. 5–10 years) about how long they have been in their relationship

^d Establishment of a sexual agreement was determined by comparing responses between the two men within the male couple. “Concurrence: yes” meant both men in the couple stated they had a sexual agreement; “Concurrence: no” meant both men in the couples stated they did not have a sexual agreement; “Non-concurrence” meant one male in the couple stated he had a sexual agreement with his main partner while the partner stated they did not have a sexual agreement

All, 6 = Agree Completely). The 22-item measure had a Cronbach’s α of 0.87.

The Trust Scale was used to assess the degree to which individuals had faith in their main partners and viewed their partners as dependable and predictable (Rempel et al., 1985). The 17-item validated measure consisted of three subscales: the predictability subscale assessed the consistency and stability of a partner’s specific behaviors based on past experience (five items, $\alpha = 0.71$); the dependability subscale assessed the dispositional qualities of the partner which warrant confidence in the face of risk and potential hurt (five items, $\alpha = 0.68$); and the faith subscale assessed feelings of confidence in the relationship and the responsiveness and caring expected from the partner in the face of an uncertain future (seven items, $\alpha = 0.86$) (Rempel et al., 1985). Response options for each item were captured on a 7-point

Likert-type scale ranging from 3 = Strongly Disagree to 3 = Strongly Agree. The overall measure had a reliability of 0.87.

The Sexual Agreement Investment Scale was used to assess participants’ value, commitment, and satisfaction with a sexual agreement with the main partner (Neilands et al., 2010). The 13-item validated measure included three domains: value of the agreement (six items, $\alpha = 0.92$), commitment to the agreement (four items, $\alpha = 0.90$), and satisfaction with the agreement (three items, $\alpha = 0.80$) (Neilands et al., 2010). A 5-point Likert-type scale (0 = Not at All, 4 = Extremely) was used for each item. The 13-item measure had a reliability of 0.94. Only participants who reported having a sexual agreement completed this measure.

Statistical Analyses

Sample size and power for estimating effects among indistinguishable dyads were determined using recommendations described by Kenny et al. (2006). Indistinguishable dyads are defined when two members of a relational dyad lack a meaningful factor for distinguishing them (i.e., gender) (Kenny et al., 2006), as in the case of gay male couples. The present study recruited a sample of 144 gay male couples. Data from two couples were dropped due to ineligibility and inconsistencies in responses. In order to achieve a power of 0.95 to measure a two-tail test of consequential non-independence, Kenny et al. (2006) recommended a sample size of 140 dyads with a medium population correlation value of 0.3 and an alpha set at 0.05. Testing for consequential non-independence was necessary to reduce the probability of committing a type I error. Based on recommendations and guidelines provided by Kenny et al. (2006), power was estimated to be 0.80 with alpha set at 0.05 for a minimum effect size of 0.50 for estimating actor–partner effects.

Based on self-reports made by both men within the couple, certain individual-level measures were categorized and coded to couple-level, dichotomous measures (i.e., race for interracial couple). Age difference within the couple was calculated by subtracting the ages between both males within the couple and then placing the couples into one of two categories: 5 years and less or greater than 5 years. Descriptive statistics including counts and percentages were calculated for some of the demographic measures.

By using Stata v11 (StataCorp LP, College Station, TX), differences in self-reports of selected relationship characteristics and common relationship factors were compared within the sample of gay male couples. Specifically, we conducted multilevel logistic regression models to compare: (1) men who had engaged in UAI with their main partner within the previous 3 months ($N = 257$) to those who had not ($N = 27$); and (2) men who had engaged in UAI with both their main partner and a casual partner within the previous 3 months ($N = 23$) to those who had not ($N = 261$). These comparisons were made to better understand the characteristics of our sample and whether self-reports of certain relationship characteristics as well as trust, relationship

commitment, and investment in one's sexual agreement differed by the participants' engagement of UAI within and outside of their relationship. Odds ratios (OR) and 95 % confidence intervals (95 % CI) were calculated for all of the comparative multilevel logistic regression models.

Data from our comparison analyses were used to help determine which demographic and relationship characteristics to assess for actor–partner effects for each of the outcome variables. However, because a limited amount of literature exists on actor–partner effects and HIV risk among gay male couples, we selected a variety of demographic and relationship characteristics to assess for actor–partner effects for each of the outcome variables. Examples of the demographic and relationship characteristics selected included participant's age, age difference within the couple, participant's race, race of the couple, relationship duration, type of relationship, and couple's concordance about having a sexual agreement. Similarly, all of the validated relationship measures (i.e., trust, commitment, investment in one's sexual agreement) were assessed for actor–partner effects for each of the outcome variables.

In detail, several models were examined for significant actor–partner effects. For each outcome variable (UAI with the main partner; UAI with both the main partner and a casual partner), four models were created to assess for relationship commitment-related effects; three models for trust-related effects; three models for investment in sexual agreement effects; and two models each for the following factors: participant's age, age difference within the couple, race, race of the couple, relationship duration, relationship type, and concordance of having a sexual agreement. The models for investment in sexual agreement effects had a sample size of 136 men (i.e., 68 dyads) because not all couples self-reported and were concordant about having a sexual agreement. All other actor–partner effect models retained data from at least 97 % of the sample. Furthermore, we constructed single-predictor actor–partner effect models due to our limited sample size of couples.

To analyze for actor–partner effects using the APIM framework, we arranged the data in a pairwise format (Kenny et al., 2006). Scores for all interval predictors (i.e., age, age difference within the couple, trust, commitment, investment in one's sexual agreement) were mean-centered. Actor and partner effects were then estimated through a series of MLM procedures with the statistical program SAS v9.2 (SAS Institute, Inc., Cary, NC). McMahon et al. (2006) provided a detailed guide on MLM of dyadic data with binary outcomes for the APIM framework. We followed instructions from this guide for the present study. A test for within-dyad interdependence was performed with the outcome variable to produce an intraclass correlation coefficient with 95 % confidence limits (CI). The intraclass correlation coefficient was significant for each analysis, which indicated there was within-cluster interdependence and that the use of a multilevel model was necessary. The SAS procedure code used for this test was PROC FREQ.

A second model was then produced to generate parameters for the final conditional random intercepts model. First, a random intercepts' variance estimate was obtained from the fixed model through the SAS PROC MIXED procedure. The random intercepts' variance estimate is an indicator for the between-cluster variance or variance due to dyads. The second model was then created through a marginal modeling approach by using generalized estimating equations (GEE). The second model (GENMOD) produced starting values of the intercept and slope parameters for the final conditional random intercepts model.

The final model incorporated the random intercepts' variance estimate (s^2u) and intercept and slope parameters (β_0 , β_1 , etc.) from the two preceding models, PROC MIXED and GENMOD respectively. The NLMIXED procedure code for SAS was used to generate the final model, along with these additional analytical options; quadrature points (QPOINTS) were added to obtain integral approximations over the random effects and an optimization technique called Newton–Raphson algorithm (NEW-RAP) was used to ensure the reliability in estimating the parameters. The parameter estimates produced from the final conditional random intercepts model were used to detect the actor and partner effects. Standard errors, degrees of freedom, t value, and lower and upper 95 % CI were also provided for each of the parameter estimates in the final model. To make the interpretation of the actor and partner effects more intuitive, we converted the coefficients and 95 % CI to adjusted odds ratios (AOR) and corresponding 95 % CI by taking their exponents. AORs and their associated 95 % CI for each of the actor and partner effects were then reported.

Results

We categorized our findings according to participants' engagement of UAI: main partner, and both main partner and a casual partner during the previous 3 months. For each of these two categories, we first highlight the comparative findings before providing the significant results of the actor–partner effects. Table 2 shows results from our comparative multilevel logistic regression models on which demographic and relationship factors were statistically associated with participants' engagement of UAI with his main partner, and UAI with both his main partner and a casual partner. Table 3 presents the actor–partner effects associated with participants' self-reported UAI with both his main partner and a casual partner.

UAI with the Main Partner

As participant's age increased by year, men were less likely to have had UAI with their main partner (OR = 0.82, 95 % CI 0.70–0.96, $p < .05$). Similarly, the likelihood that a participant had UAI with his main partner decreased as relationship duration increased (OR = 0.01, 95 % CI 0.00–0.08, $p < .001$); most men

Table 2 Statistical differences of relationship characteristics and factors by participants' self-reported engagement of UAI among 142 gay male couples

Characteristic	UAI with main partner		UAI with both main partner and casual partner	
	Yes 257 OR (95 % CI)	No 27	Yes 23 OR (95 % CI)	No 261
Sample size: individuals				
Age of the participant	0.82 (0.70–0.96)*		1.03 (0.95–1.10)	
Age difference within the couple (<5 years vs. >5 years)	2.34 (0.13–43.61)		1.33 (0.30–5.93)	
Race of the participant (non-White vs. White)	0.76 (0.07–8.80)		0.49 (0.07–3.21)	
Race of the couple (interracial couple vs. non-interracial)	0.28 (0.01–5.53)		0.35 (0.06–2.00)	
Type of relationship (strictly monogamous vs. open to some degree)	1.45 (0.08–27.57)		0.05 (0.01–0.34)**	
Couple lived together	0.01 (0.00–0.49)		1.26 (0.21–7.72)	
Relationship duration	0.01 (0.00–0.08)***		1.39 (0.84–2.28)	
Relationship factor				
Trust scale				
Predictability	0.50 (0.16–1.51)		0.79 (0.48–1.29)	
Dependability	0.99 (0.30–3.26)		0.88 (0.54–1.44)	
Faith	0.89 (0.27–2.97)		0.80 (0.42–1.54)	
Investment model				
Commitment level	0.47 (0.04–4.94)		0.49 (0.24–1.01)	
Relationship satisfaction	0.69 (0.19–2.53)		0.62 (0.34–1.13)	
Investment	0.61 (0.09–4.04)		1.40 (0.60–3.27)	
Quality of alternatives	1.52 (0.43–5.40)		0.56 (0.33–0.95)*	
Sexual agreement investment scale ^a				
Value	2.02 (0.32–12.60)		0.11 (0.02–0.71)*	
Commitment	2.83 (0.38–20.98)		0.23 (0.07–0.70)**	
Satisfaction	3.95 (0.57–27.56)		0.53 (0.21–1.36)	
Concordance on having a sexual agreement ^b	0.41 (0.03–6.27)		2.86 (0.70–11.70)	

Note. Results of OR and 95 % CI are from comparative multilevel logistic regression analyses

* $p < .05$, ** $p < .01$, *** $p < .001$

^a Of the 74 gay male couples, 51 had discrepant reports about having a sexual agreement. Data for the sexual agreement investment scale reflects the individual scores from the 51 men in the discrepant couples

^b Of the 142 gay male couples, 68 couples ($N = 136$ MSM) concurred about having a sexual agreement

who did not have UAI with their main partner had been in their relationship for 5 years or longer. No other demographic or relationship factor was significantly associated with participant's having had UAI with their main partner within the previous 3 months. Moreover, no actor-partner effects of the above mentioned factors were statistically significant for predicting UAI with the main partner (results not shown).

UAI with Both the Main Partner and a Casual Partner

Men who self-reported having a strictly monogamous relationship were less likely to have had UAI with both his main partner and a casual partner compared to those who self-reported having an open relationship (OR = 0.05, 95 % CI 0.01–0.34, $p < .01$). The odds of engaging in UAI with both the main partner and a

casual partner were negatively associated with quality of alternatives (OR = 0.56, 95 % CI 0.33–0.95, $p < .05$). Further, the odds of engaging in UAI with both a main partner and a casual partner were also negatively associated with value of a sexual agreement (OR = 0.11, 95 % CI 0.02–0.71, $p < .05$), and commitment to a sexual agreement (OR = 0.23, 95 % CI 0.07–0.70, $p < .01$). No other demographic or relationship factor was significantly associated with participant's having had UAI with both their main partner and a casual partner during the same timeframe.

In our APIM analyses, three actor effects and four partner effects were found to be statistically significant in predicting whether a member within the male couple has had UAI with both his main partner and a casual partner during the same timeframe. Actor effects for value in a sexual agreement (AOR = 0.15, 95 % CI 0.03–0.76, $p < .05$), commitment to a sexual agreement

Table 3 Adjusted odds ratios and 95 % CI for demographic and relationship factors of actor–partner effects associated with participants' self-reported UAI with both his main partner and a casual partner within the previous 3 months

	Actor effect		Partner effect	
	AOR	95 % CI	AOR	95 % CI
Demographic factor				
Age of the participant	1.02	(0.93–1.12)	0.90*	(0.82–0.99)
Relationship factor				
Trust scale				
Predictability	0.75	(0.46–1.24)	0.60	(0.36–1.01)
Dependability	0.97	(0.58–1.63)	0.58*	(0.34–0.98)
Faith	0.80	(0.42–1.50)	0.70	(0.37–1.31)
Investment model				
Commitment level	0.51	(0.25–1.06)	0.83	(0.40–1.72)
Relationship satisfaction	0.67	(0.36–1.26)	0.62	(0.33–1.16)
Investment	1.69	(0.71–4.04)	0.34*	(0.13–0.86)
Quality of alternatives	0.54*	(0.30–0.97)	0.52*	(0.29–0.95)
Sexual agreement investment scale				
Value	0.15*	(0.03–0.76)	0.96	(0.25–3.74)
Commitment	0.22*	(0.06–0.79)	0.98	(0.31–3.10)
Satisfaction	0.38	(0.13–1.13)	0.80	(0.28–2.25)

Notes. Each actor–partner effect model included self-reported scores from both men in the couple on the independent factor of interest and outcome

* $p < .05$

(AOR = 0.22, 95 % CI 0.06–0.79, $p < .05$), and quality of alternatives to the relationship (AOR = 0.54, 95 % CI 0.30–0.97, $p < .05$), were statistically significant for predicting whether a member within a couple had UAI within and outside of his relationship. For example if we hold the partner effect constant, the significant actor effect indicated that for each one point increase in the actor's score of value in the sexual agreement, the odds of that individual having had UAI with a casual partner decreased by 0.15. In other words, for each one point increase in the actor's score for valuing the sexual agreement he has with his main partner, the odds of him having had UAI within and outside the relationship decrease by 85 %. Similarly, for each point increase in the actor's score for commitment to the sexual agreement with his main partner, the odds that he has had UAI with both his main partner and a casual partner decrease by 78 %; for quality of alternatives, the odds of him having had UAI within and outside the relationship decrease by 46 %.

Partner effects for age (AOR = 0.90, 95 % CI 0.82–0.99, $p < .05$), dependability of trust (AOR = 0.58, 95 % CI 0.34–0.98, $p < .05$), investment of relationship commitment (AOR = 0.34, 95 % CI 0.13–0.86, $p < .05$), and quality of alternatives to the relationship (AOR = 0.52, 95 % CI 0.29–0.95, $p < .05$) were statistically significant for predicting whether the other member within the couple had UAI within and outside of the relationship. For example, if we hold the actor effect constant, the significant partner effect

indicated that for each one year increase in a partner's age, the odds of the other member having had UAI within and outside of the relationship decrease by 10 %. Further, if we hold the actor effect constant, for each one point increase in one partner's score of perceived dependability regarding trust, the odds of the other member having had UAI within and outside of the relationship decrease by 42 %. Similarly, for each one point increase in one partner's score of investment of relationship commitment with his main partner, the odds of the other member having had UAI within and outside of the relationship decrease by 66 %; for quality of alternatives, the odds of the other member having had UAI within and outside the relationship decrease by 48 %. No other actor or partner effects were statistically significant in predicting UAI with both the main partner and a casual partner.

Discussion

The main advantage for estimating actor–partner effects is to assess whether relationship factors *within* gay male couples influence each partner's risk for HIV. Similar to other studies with gay male couples, the majority of our sample self-reported having UAI with their main sex partners in the previous 3 months (Appleby et al., 1999; Blais, 2006; Crawford et al., 2003; Davidovich et al., 2000, 2004, 2006; de Vroome et al., 2000; Hoff & Beougher, 2008; Hoff et al., 2009; LaSala, 2004a, b; McLean et al., 1994; McNeal, 1997; Prestage et al., 2006, 2008; Worth et al., 2002). Yet, no actor or partner effects of demographic and relationship characteristics, trust, commitment to the relationship, and investment in one's sexual agreement were significantly associated with UAI occurring within the relationship. One possible explanation is that other factors, such as power, social support, and communication within the couple, may exist and influence whether men have UAI with their main partners.

On the other hand, several actor–partner effects of relationship factors were significantly associated with whether men in the couple have had UAI with both their main partner and a casual partner during the same period of time. Our findings suggest that an individual's value and commitment to his sexual agreement are important for reducing HIV risk within a relationship. To a lesser degree, quality of alternatives to the relationship, perhaps an individual's feeling about what it would be like to be single, also seem to have a protective factor for decreasing the odds that one of the men in the couple had UAI within and outside of their relationship. These actor effects may indicate the extent to which an individual evaluates his value and commitment to the sexual agreement, and compares the quality of alternatives that he perceives are available to him. These perceived assessments could help an individual decide what he values about being in the relationship with his main partner and whether or not to engage in UAI within and outside of the relationship.

A participant's age, perception of whether his partner is dependable (for trustworthiness), investment that exists within

the relationship, and quality of alternatives appear to positively and directly reduce the chances that his partner would have had UAI within and outside the relationship (i.e., UAI with both the main partner and a casual partner). These partner effects suggest that having stability or a sense of security in the relationship could be important components to reducing HIV risk among gay male couples. For instance, the more investment and dependability that an individual experiences within the relationship, the less likely that his partner would have had UAI within and outside the relationship. Having an older male partner may also be associated with viewing the relationship as being more stable. Overall, our study supports how relationship factors and behaviors within gay male couples are interdependent in nature; as in, trust, relationship commitment, investment in a sexual agreement, and having had UAI all require the participation of both men within the relationship.

This study is not without limitations. Our cross-sectional study design precludes us from making causal inferences. Our convenience sample from the Portland and Seattle metropolitan areas limits the generalizability of our results to other male couples that may live elsewhere. We also did not collect data on the timing of when UAI with the main partner had occurred with respect to a casual partner; the HIV serostatus of the casual partners, and whether the seroadaptive practices of serosorting (CDC, 2009, 2010; Eaton et al., 2009; Parsons et al., 2005), strategic positioning (CDC, 2009; Parsons et al., 2005; Van De Ven et al., 2002), and withdrawal (Parsons et al., 2005) were used by any of the study participants. Also, the actor–partner analyses we used only examined one predictor with an outcome at a time. As such, measurement of shared variance amongst predictors was not possible. Future research that uses structural equation modeling with dyadic data is needed to address how various factors are interrelated and contribute to HIV risk among gay male couples. Despite these limitations, our study strengths include having a moderate sample size of male couples and using dyadic data to measure actor–partner effects through a series of MLM analyses. To the best of our knowledge, results from this study are the first to: (1) show whether actor–partner effects of trust, relationship commitment, and investment in one’s sexual agreement are significantly associated with an individual’s and his partner’s self-reports of UAI with both the main partner and a casual partner; and (2) indicate that actor–partner effects of these factors were influential for decreasing the likelihood that UAI occurred both within and outside of the relationship, and as such, reducing the risk of HIV within this sample of gay male couples.

As evidenced by our findings, future HIV prevention strategies should take into account how relationship factors influence an individual and his main partner’s sexual risk behaviors and in turn, the couple’s risk for HIV. HIV prevention interventions and programs may benefit by including components that aim to strengthen the relationship of gay male couples in order to capitalize on the direct influences that relationship factors have on reducing HIV risk for the individual, his partner, and the couple

overall. Furthermore, HIV prevention and sexual health programs should also consider how best to facilitate and enhance: (1) the sense of stability and security within gay male couples and (2) how gay men can best assess the positive attributes within their relationships. However, new research that collects dyadic data from diverse populations of gay male couples and uses other analytical techniques is urgently needed to increase our understanding of the extent to which actor–partner effects of relational and other factors influence HIV risk.

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