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# The implications of respondent concurrency on sex partner risk in a national, web-based study of men who have with men in the United States

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## Abstract

**Background—**Men who have sex with men (MSM) represent the largest HIV risk-group in the United States. Sexual concurrency catalyzes HIV transmission in populations by increasing the indirect exposure of one's sex partners to one another. Methods are lacking for understanding the exposure implications for partners (dyads) reported in individual-level (egocentric) designs studies.

**Methods—**We developed a technique for measuring the indirect exposure of respondents' partners to other partners. Two partner-level outcomes were constructed: any concurrent *or* serially monogamous exposure ('any exposure'), and any concurrent exposure, irrespective of serial monogamy ('any concurrent exposure'). Reported unprotected anal intercourse (UAI) was incorporated to calculate outcomes of 'any UAI exposure' and 'any concurrent UAI exposure'. This method was applied to an online study of MSM aged ≥ 18 years, with comparisons made by partner race-ethnicity, age, type, and meeting location.

**Results—**Among 4,060 repeat partners of 2,449 MSM, 73% had any exposure in the previous 6 months; 58% had any concurrent exposure. Among UAI partners, 37% had concurrent UAI exposure. Black UAI partners were more likely than white ones to have any concurrent UAI exposure (unadj. OR [95% CI] = 1.34 [1.05, 1.70]), as were casual UAI partners relative to main partners (4.37 [3.58, 5.35]). In adjusted models, black UAI partners were more likely to have any UAI exposure, but not concurrent UAI exposure. Casual UAI partners remained more exposed by both outcomes.

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**Conflicts**
No conflicts of interest to declare.

**Conclusions—**Sex partners of MSM, particularly casual and black non-Hispanic partners, face a high degree of exposure to other partners.

### Keywords

concurrency; HIV; MSM; sexual risk; concurrency methods

## Introduction

Since the earliest reports of AIDS in the United States, men who have sex with men (MSM) have been the most affected risk group in the US HIV/AIDS epidemic.[1] In 2009, MSM accounted for 61% of new HIV infections, and from 2007–2009 an estimated 24,220 MSM died with an AIDS diagnosis.[2,3] In addition to the HIV disparities between MSM and other groups, substantial racial/ethnic disparities among MSM, with black non-Hispanic MSM facing the greatest burden of both HIV prevalent [4] and incident infections.[3] In addition to recognized transmission probability differences between anal and vaginal intercourse,[5,6] differences in partnership and sexual network factors are emerging that may additionally explain the disparity in HIV incidence between MSM and heterosexuals.[7] It is less understood which factors are driving racial/ethnic differences among MSM, because insufficient evidence of elevated individual-level risk behaviors has been found among MSM of color.[8,9]

Sexual network differences have been hypothesized but remain inadequately documented.[8,9] Sexual concurrency is considered a potentially important network determinant of HIV/STI transmission, and is defined as "*overlapping sexual partnerships where sexual intercourse with one partner occurs between two acts of intercourse with another partner*".[10] Concurrency has the potential to foster propagation in populations by increasing both the indirect exposure of partners to one another (e.g. network connectivity) and the likelihood of transmission during acute infection.[11,12] Three recent reports have indicated a high prevalence of concurrent sex among MSM respondents in the United States, using various measures, with estimates ranging from 18% – 78% in the previous year, [7,13,14] all of which are substantially higher than reported among heterosexual men.[7,15] Our previous report additionally documented a 16% six-month prevalence of concurrent unprotected anal intercourse (UAI) with two partners, which is a biologically relevant metric for concurrency among MSM, and also described the prevalence of concurrency among triads, the basic unit of concurrency formed by an individual and two partners.[13]

Simulation- and couples-based studies have respectively lent strong theoretical and empirical support for concurrency's causal role in facilitating HIV transmission.[16–18] However, a greater number of concurrency investigations have been individual-level (egocentric) studies, where only the respondent is interviewed and not his or her sex partners. Considerable controversy has developed over the use of egocentric studies to provide empirical evidence in support of or against the transmission effects of concurrency, because of the inconsistent evidence these studies have provided and fundamental flaws in their designs and analyses. A common analytical fallacy underlying many egocentric concurrency studies [19–21] is relating a person's concurrent sex to that same person's HIV acquisition risk.[22] In reality, one's concurrency affects the risk of HIV acquisition for one's partners, a phenomenon not directly assessed in egocentric designs. Conversely, an individual's HIV risk is affected by the concurrency of his partners; concurrency of partners is challenging to ascertain accurately in an egocentric design.

Other than the consideration of more complex study designs, few solutions have been proposed to address these limitations in egocentric studies. As a result, such studies can only appropriately report the prevalence and correlates of concurrent sex among study participants and inference to HIV transmission risk cannot be directly made. Our previous report of individual concurrency found equivalent prevalence in white, black, and Hispanic MSM, but this is inadequate for inference about race-specific HIV acquisition risks due to concurrency.[13] The partners of study participants (respondents) were put at risk by indirect exposure to other partners (that is, exposure through the respondent). Thus, it is the partners' race/ethnicities that are relevant. Compared to heterosexual dyads,[23] MSM dyads demonstrate less assortative mixing by race,[24–26] and therefore respondents' race/ethnicities are not good markers for partners' race/ethnicities. Analyses of these data that consider the partners' perspectives (and race/ethnicities) are required to appropriately to understand racial/ethnic differences in risk.

In our previous study we demonstrated a method for accurately assessing the timing of sexual partnerships (and thus concurrency) and merged this information with risk behaviors to measure "biologically relevant concurrency", the form of concurrency that would enable HIV transmission and defined as having UAI with each of two concurrent sex partners.[13] We extend these tools in this report, introducing a new method for using egocentric data to assess the increased indirect exposure of respondents' partners to each other due to the patterns of concurrency and serial monogamy that respondents report. Using data from an online study of MSM, we use this method to assess the indirect exposure that male sex partners experience, with emphasis on understanding racial/ethnic heterogeneity in this exposure as a possible explanation for disparities in HIV incidence among MSM.

## Methods

### Study design

Data are from baseline responses of participants in a 12-month prospective online study of HIV behavioral risks among MSM in the United described elsewhere.[13,25,27] Briefly, MSM were recruited from August – December 2010 through selective placement of banner advertisements on social networking websites (e.g., Facebook, MySpace, although limited recruitment occurred on the dating website Adam4Adam).. Eligibility requirements for the baseline questionnaire were male sex, 18 years of age or older, and having had a male sex partner in the past 12 months. Following online consent, respondents completed a 60-minute questionnaire. The study was reviewed and approved by the Institutional Review Board of Emory University (IRB #00031326).

### Sexual concurrency and partnership data collection

Respondents who had ≥ 1 sex partner in the 6 months before interview were asked to provide nicknames for up to 5 most recent sex partners (anal, oral, or vaginal sex) within the previous 6 months. They then completed a month-level calendar grid to establish the sequence and potential overlap of sexual partnerships. To improve accuracy, follow-up questions were asked to clarify ambiguous response patterns.[13,28] This was followed by a behavioral inventory for each partner.

### Individual level concurrency outcomes (concurrency prevalence)

Measures of concurrency prevalence among individual respondents were calculated as described previously.[13] Briefly, each unique combination of a respondent and two reported sex partners composed a triad; because each respondent could name up to 5 partners, he contribute 0–10 triads (Figure 1). Triads were considered concurrent if the months of sexual activity with both partners overlapped by ≥ 2 months; if they overlapped by 1 month and one partner's interval entirely contained the 1- month relationship of the other partner; or the respondent confirmed concurrency in answer to the clarification questions. Triads were also classified according to whether UAI occurred with both partners in the previous 6 months. Examining the triadic determinations for each participant, we defined the two participant-level dichotomous outcomes having ‘any concurrent partnerships’ and ‘any concurrent UAI partnerships’ in the previous 6 months.[13,29]

### Dyad-level outcomes (indirect exposure)

For each named partner of a given respondent, we conceptualized indirect exposure as the exposure to any other partners due to that respondent’s patterns of concurrent and/or serial monogamous partnerships. This was operationalized using 4 partner- (dyad) level outcomes that dichotomously classified exposure to at least one other partner. The first two outcomes were 1) any (concurrent or serial) exposure and 2) any concurrent exposure. These outcomes are not mutually exclusive and provide complimentary information about indirect exposure: the first quantifies the general exposure and connectivity among partners and the second isolates that which is attributable to concurrency. Because indirect exposure is most biologically relevant for HIV transmission when UAI has additionally taken place, the latter two outcomes considered UAI: 3) any (concurrent or serial) UAI exposure, and 4) any concurrent UAI exposure.

The method for computing these outcomes is illustrated by example in Figure 2, which depicts a hypothetical respondent (‘Ego’) and his 4 partnerships (Partners A–D). In Figure 2, Part 1, Ego and his 4 partners are displayed in a traditional egocentric network view as well as a timeline view that displays the sequencing of the 4 partners in time. In this latter view, some pairs of partners (i.e., triads) are concurrently, while others are serially, arranged.

Figure 2, Part 2 focuses on deriving the indirect exposure outcomes for Partner A, and depicts the 3 triads involving Partner A in Parts 2.I - Parts 2.III. At left the earlier two views highlight the sequence and behaviors in the triads of interest and at right, two additional views interpret the implications of these patterns for the Ego and for Partner A.

In the first triad (Part 2.I), Ego’s concurrent UAI with Partners A and B, indirectly exposes A to B by UAI. In the second triad (Part 2.II), Ego’s serial sex with Partner C before A, indirectly exposes A to C, by not by UAI because sex with Partner C was protected. In the third triad (Part 2.III), Ego’s serial UAI with Partner A before D, does not place A at risk because this relationship sequence is protective.

In Figure 2, Part 3, the findings from the 3 triads are collated to compute each of the 4 indirect exposure outcomes for Partner A. Because of the concurrent UAI exposure to Partner B (Part 2.I), Partner A is classified as having met all 4 outcomes of ‘any exposure’, ‘any concurrent exposure’, ‘any UAI exposure’, and ‘any concurrent UAI exposure’. Had Ego’s relationship with Partner B not existed, Partner A would satisfy only the first outcome of ‘any exposure’, owing to the serially monogamous exposure (without UAI) to Partner C (Part 2.II), and would thus have no exposure derived from Ego’s concurrent sex. This is why comparing the ‘any exposure’ and ‘any concurrent exposure’ outcomes allows one to assess the causal contribution of concurrency to partners’ indirect exposure risk.

In Figure 2, Part 4, this process is repeated to derive the indirect exposure outcomes for the remaining Partners B–D.

More generally, given *p* total partners, there are *p-1* triads to examine for each partner of interest. The triadic patterns of concurrency and serial monogamy in which the relationship with the partner of interest occurs later (Part 2.I and 2.II) may count towards the indirect exposure outcomes of interest for that partner. Note that multiple triads may count towards a given dichotomous exposure outcome. The third pattern of serial monogamy, in which the partner of interest occurs first (Part 2.III) does not count towards exposure risk outcomes. The additional requirement of UAI with both partners in a triad is overlayed on top of the first two exposure outcomes to help derive the'UAI exposure' ones.

By restricting analysis of these two UAI exposure outcomes to just UAI partners, indirect exposure may be most validly quantified among the subset of partners generally considered at behavioral risk. Failure to restrict these analyses allows the prevalence of UAI among partners to confound association with the exposure outcomes.

## Analytic sample

Of the original 6,104 men in the study, 3,768 had at least one male contact in the preceding 6 months, and 3,471 completed the calendar grid (Supplemental Digital Content Figure 1). Several modifications were made to the original sample of respondents and partners to permit valid inference. Only respondents who did not self-report being HIV-positive were included (n = 3,118 respondents; 9,263 dyads). This is because HIV-positive individuals may *directly* place their partners at risk for acquiring HIV, and accordingly the indirect exposure of partners to other (HIV-infected) partners is irrelevant.[22] An exception is the case of recently infected individuals who may have transmitted HIV from one (concurrent) partner to another in the recall period. Although pertinent, it is unlikely that more than a negligible proportion of the total respondents self-reporting being HIV-positive would be recently infected.

Partners with whom sex occurred only once were excluded (n=3,118 dyads; 38% of reported partners) since they cannot be put at risk by the respondent's concurrency. For one-time casual sex partners, all risk to the one-time partner is by definition from serially preceding partners. One-time partners may, however, contribute to risk to other partners imparted by the respondent's concurrency and they were therefore counted as the potential purveyor, but not potential recipient, of concurrency risk.

Because our analysis was primarily focused on understanding racial/ethnic disparities in HIV risk, we examined only partners reported to be white non-Hispanic, black non-Hispanic, and Hispanic race/ethnicity, analogous to our previous report,[13] irrespective of the race/ethnicity of the study participant (n=2,449 respondents; 4,060 dyads).



## Statistical Analysis

Respondent-level demographics characteristics, previous six-month concurrency prevalence and concurrent UAI prevalence were tallied. At the dyad level, we summarized partner race/ethnicity, partner age, main/casual partner type, whether the partner was met online, and previous six-month sexual repertoire (categorized as: UAI; protected AI/oral sex, oral sex only). The 4 partner-level indirect exposure outcomes was computed for partners in all their possible triads, and was characterized by partner race/ethnicity, age, main or casual partner, online meeting status, and sexual repertoire. Summarization of the two UAI exposure outcomes was restricted to partners with whom UAI occurred in the recall period, as explained above. The prevalence of each exposure outcome was compared between the levels of each factor using bivariate odds-ratios (OR) with 95% confidence intervals (CI) and the $\chi^2$ test.



Logistic regression models were fit for each outcome that included all partner factors as well as interactions of race/ethnicity with age and main/casual partner type. Models of UAI outcomes excluded sexual repertoire as a predictor. Adjusted ORs and 95% confidence intervals for race/ethnicity and partner type were computed. Since the exposure outcomes of partners from the same respondents are correlated, we adjusted the OR estimates in four corresponding repeated measures GEE logistic regression models with exchangeable ln(OR) correlation structures.[30] All models' interaction terms in the non-repeated and repeated models were retained if they respectively had a Wald or Score Test p < .05. All analyses were conducted in SAS ver 9.3.

## Results

Of the 6,104 MSM who began the survey, 3,471 provided sufficient data on sexual partnerships in the previous 6 months and their timing (Supplemental Digital Content Figure 1). Among these, 3,118 (90%) completed the HIV testing questions and did not report an HIV-positive test result, forming the base respondent sample that contributed sex partners to this analysis. This sample of respondents was 54% white non-Hispanic, 16% Black non-Hispanic, 15% Hispanic, and 15% of other race/ethnicity. The median age was 26 (IQR: 21–36) years. Seventy-nine percent self-identified as homosexual or gay, 18% as bisexual, 1% as straight, and 2% used another other term. These respondents reported a total of 9,263 sex partners from the previous 6 months, yielding a median partner count of 3 (IQR: 1, 5). Based on the timing of sexual contacts provided for the 14,322 triads formed between respondents and their partners, 44% (1,362/3,118) of the respondents reported any concurrent partnerships and 14% reported any concurrent UAI partnerships (379/2651) in the previous 6 months, with no significant differences by respondent race/ethnicity.

Among the 9,263 partners, 5,184 (56%) had repeated sexual contact with the respondent. Of these partners with repeated contact, 4,060 (78%) were white non-Hispanic, Black non-Hispanic, or Hispanic and made up the set of partners included in analyses of indirect exposure attributable to the partnership timing of respondents (Supplemental Digital Content Figure 1). The 4,060 partners were named by 2,449 different respondents.. By race/ethnicity, the partners were 60% white non-Hispanic, 21% Black non-Hispanic, and 19% Hispanic. The median age was 27 (IQR: 22–36) years, 59% were casual partners, 48% were met online, and 54% were partners with whom UAI occurred in the previous 6 months (Table 1a).

Overall, 73% of partners had any (serial or concurrent) exposure to other partners, while 58% had any concurrent exposure (Table 1B). Black and Hispanic partners were more likely than white partners to have any exposure (crude. OR [95% CI] = 1.34 [1.11, 1.60] and 1.3 [1.1, 1.5], respectively), but no differences by race/ethnicity in any concurrent exposure were observed. Having any exposure did not significantly vary by age group; however, compared to partners under 25 years of age, those above 40 years of age were more likely to have concurrent exposure to other partners (crude. OR [95% CI] = 1.7 [1.3, 2.2]). Being a casual partner substantially increased the odds of both exposure outcomes (crude. OR [95% CI] = 5.1 [4.4, 6.0] and 3.3 [2.9, 3.8] for serial or concurrent and concurrent exposure, respectively) and 69% of casual partners were concurrently exposed.

Forty-eight percent of UAI partners had any UAI exposure to other partners, and 37% were exposed by concurrent UAI (Table 2b). Black UAI partners were more likely to be exposed by UAI (crude OR [95% CI] = 1.5 [1.2, 1.9] and 1.3 [1.1, 1.7], for any UAI exposure and any concurrent UAI exposure, respectively) relative to white UAI partners, but no significant difference was seen between Hispanic and white partners. No significant associations were observed by age group. Relative to main UAI partners, casual UAI partners were far more exposed to other partners by UAI, either by either outcome (crude OR [95% CI] = 5.3 [4.4, 6.5] and 4.37 [3.6, 5.4], respectively). Sixty-eight percent of casual UAI partners had any UAI exposure to other partners in the previous six months.

In all multivariable models (either adjusted for or not adjusted for repeated measures), the interaction terms with race and age and partner type were not significant, yielding main-effects only models that controlled for race, age, partner type, and location of meeting place. In each model, casual partners were significantly more likely to be exposed to other partners through UAI, but the associations were diminished after accounting for repeated observations on respondents (Table 3). After adjustment, black partners and black UAI partners still had significantly elevated odds for having any exposure to other partners (Table 3, models 1a, 1b, 3a, 3b). Yet when examining exposure due to any concurrency and any concurrent UAI between black and white partners, no significant differences were observed (Table 3, models 2a, 2b, 4a, 4b).

## Discussion

We found high levels of concurrent indirect exposure to other recent sex partners in an online sample of MSM. Nearly half of respondents' UAI partners were indirectly linked to another partner by UAI in the previous six months (Table 2), a large proportion of which was attributable to concurrent UAI. Further, the extent to which men are indirectly exposed to other men via concurrent sex is greater than the extent to which MSM report individual-level concurrency.[7,13] This result is expected because individual-level prevalence measures include men who report exclusively one-time partners. These results together suggest substantial connectivity and opportunities for HIV/STI transmission in the networks of MSM who have UAI, and each act of UAI may impose risks for exposure to HIV that transcend the partnership. Although no comparable heterosexual estimates are available, the prevalence of concurrency and partner numbers among US heterosexual males are substantially lower than for MSM.[7,15,31] Female partners of heterosexual males would thus be expected to be at less indirect risk than male partners of MSM.

Racial/ethnic heterogeneity was observed in partner risk. Black partners were more likely than white partners to be exposed to other partners, and black UAI partners were more likely to be exposed to other partners by UAI overall and because of concurrency. This finding indicates that black partners were placed at greater risk than were white partners by study respondents. That the association with any concurrent UAI exposure was removed after controlling for repeated participant measures suggests that particular higher-risk respondents who had black partners may have contributed to this result. The racially-equivalent prevalence of concurrency among respondents also supports the notion that a combination of possibly unmeasured respondent, relationship, or situational factors put black partners at greater indirect exposure risk. Future analyses should identify and explore these factors. Nonetheless, these findings add to an emerging body of evidence supporting the hypothesis that black MSM are more likely to be placed at greater HIV risk by underlying sexual network and partnership properties. [32–36]

Casual sex partners were far more likely than main partners to be exposed to other partners. This may indicate a stronger role for HIV transmission among casual partners than suggested by previous analyses that did not explicitly model concurrency.[37,38] A reason for this difference may be our restriction to only repeat casual partners (50% of casual partners described). Furthermore, our exposure outcome was dichotomous and did not consider coital frequency,[39–41] which is substantially less with casual partners.[37,42] Adjusting for the frequency of sex would be expected to increase the risk for main partners, and frequency of sex was a significant driver in a previous analysis that suggested a more prominent role for transmission from main partners.[37] Further epidemiological studies should incorporate coital frequency and modeling studies should incorporate concurrency to help determine the true relative risk that casual partners face and their contribution to transmission overall.

Further investigation of respondent risk factors is needed to examine both individual-level and situational factors that put partners at risk. Respondent attributes, particularly relating to partner choice and configuration, are relevant for intervention development, because the greatest level of agency lies with these individuals and not their sex partners. The division between who is in control of and affected by concurrent partnering presents a unique challenge in the development of concurrency interventions.

The UAI outcomes chosen for this study are basic, dichotomous measures of the existence of a biologically plausible route of HIV transmission between sex partners. In addition to considering coital frequency, as discussed, future work should incorporate more detailed partnership information, including the exact sequencing of UAI acts, rather than partnerships, and factors that modify the probability of HIV transmission such as sexual positioning, circumcision, and the HIV infection, viral load, and treatment status of sex partners.[43]

Inference from this presentation is limited by the absence of actual transmission outcomes for partners. Though our approach may add to an understanding of the partner and network exposure configurations that result from concurrency, it adds no empirical evidence to prove or disprove concurrency's role in HIV transmission, a subject of much debate that requires alternative study designs.[44]

Because all data on partners were provided by study respondents, all partner attributes were assigned by the respondents, allowing for the misclassification of partner race/ethnicity. While we know of no studies of the agreement of intra-partnership racial classification among MSM, other work suggests that such misclassification would be low for the racial/ethnic categories used.[45,46]

Evidence is emerging for the important role of concurrency in HIV epidemics, and for the high prevalence of concurrency among MSM. We extended existing methods for understanding concurrency in egocentric studies and demonstrated that sex partners of MSM, particularly casual and black non-Hispanic partners, face a high burden of exposure to other partners, due to both concurrency and serial monogamy. This potentially puts these partners at high levels of HIV/STI acquisition risk and may help to explain HIV transmission disparities both between MSM and heterosexuals and among MSM.

Although the optimal intervention to reduce this extensive indirect exposure is unclear, behavioral interventions to reduce partner number and concurrent partnerships, [47] promote agreements about monogamy in MSM relationships, and encourage discussions and disclosure of 'outside' partners in existing relationships may all be effective. [48] Additionally, consistent condom use and adherence to treatment as prevention strategies among all MSM (ref) all can offer protection against HIV transmission due to indirect exposure to other sex partners.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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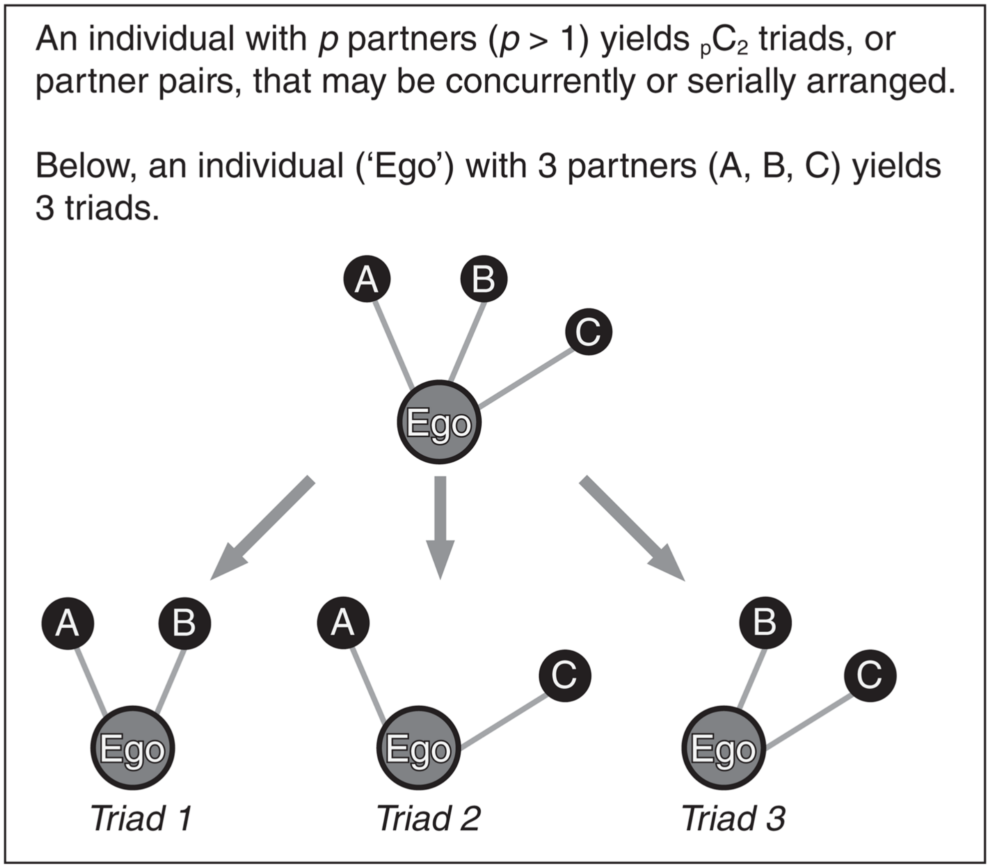


**Figure 1.**
Triads

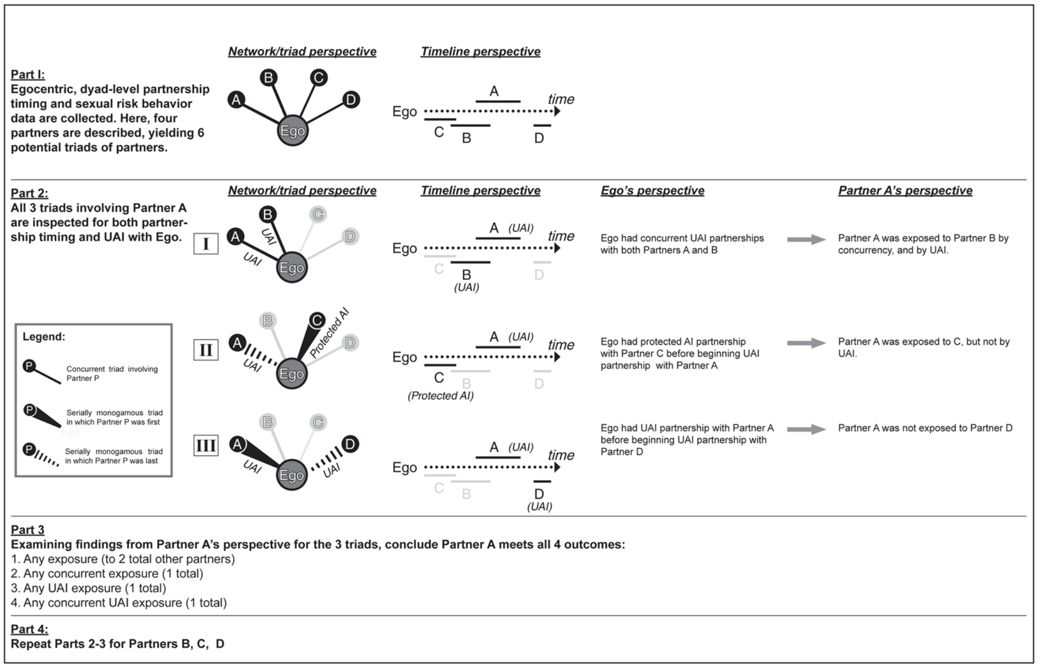


**Figure 2.**

Example of method for using egocentric partnership timing data to understand partners' indirect exposure

**Table 1**

Characteristics of and indirect exposure among 4,060 sex partners with repeated contact to HIV-negative/unknown study participants

| **A. Partner characteristics** | | | **B. Type of partner indirect exposure** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Total** | | **Any exposure** | | | | **Any Concurrent Exposure** | | | |
| | ***col %*** | ***(n)*** | ***row %*** | ***(n)*** | ***OR*** | ***(95% CI)*** | ***row %*** | ***(n)*** | ***OR*** | ***(95% CI)*** |
| **Overall** | | (4,060) | 73.4 | (2,980) | -- | -- | 57.7 | (2,343) | -- | -- |
| **Partner factors** | | | | | | | | | | |
| **Race/ethnicity** | | | | | | | | | | |
| White non-Hispanic | 60.1 | (2,439) | 71.4 | (1741) | *ref.* | | 56.9 | (1388) | *ref.* | |
| Black non-Hispanic | 21.0 | (853) | 76.9 | (656) | 1.34 | (1.11, 1.60) | 58.9 | (502) | 1.08 | (0.92, 1.27) |
| Hispanic | 18.9 | (768) | 75.9 | (583) | 1.26 | (1.05, 1.52) | 59.0 | (453) | 1.09 | (0.92, 1.28) |
| **Age** | | | | | | | | | | |
| < 25 | 38.3 | (1,529) | 72.1 | (1103) | *ref.* | | 52.7 | (805) | *ref.* | |
| 25 – 29 | 20.3 | (811) | 75.0 | (608) | 0.91 | (0.71, 1.17) | 58.9 | (478) | 1.21 | (0.95, 1.52) |
| 30 – 39 | 22.9 | (912) | 71.8 | (655) | 1.11 | (0.86, 1.44) | 58.3 | (532) | 1.20 | (0.95, 1.53) |
| 40+ | 18.5 | (737) | 75.2 | (554) | 1.19 | (0.90, 1.57) | 64.6 | (476) | 1.70 | (1.31, 2.21) |
| **Partner type** | | | | | | | | | | |
| Main | 41.3 | (1,654) | 55.0 | (909) | *ref.* | | 40.6 | (671) | *ref.* | |
| Casual | 58.7 | (2,352) | 86.2 | (2027) | 5.11 | (4.39, 5.95) | 69.4 | (1632) | 3.32 | (2.91, 3.79) |
| **Location met** | | | | | | | | | | |
| Offline | 52.1 | (2,079) | 71.6 | (1488) | *ref.* | | 57.8 | (1202) | *ref.* | |
| Online | 47.9 | (1,914) | 75.2 | (1438) | 1.20 | (1.04, 1.38) | 57.1 | (1092) | 0.97 | (0.86, 1.10) |
| **Sexual repertoire** | | | | | | | | | | |
| Unprotected anal intercourse | 53.7 | (2,004) | 68.5 | (1373) | 0.71 | (0.58, 0.86) | 54.4 | (1091) | 1.00 | (0.84, 1.19) |
| Protected anal intercourse / Oral sex | 28.4 | (1,060) | 80.0 | (848) | 1.30 | (1.03, 1.64) | 63.1 | (669) | 1.43 | (1.18, 1.74) |
| Oral sex only | 17.8 | (665) | 75.5 | (502) | *ref.* | | 54.4 | (362) | *ref.* | |

## Table 2

Characteristics of and indirect unprotected anal intercourse (UAI) exposure among 1,885 UAI partners with repeated contact to HIV-negative/unknown study participants

| **A. Partner characteristics** | | | **B. Type of partner indirect exposure** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Total [1]** | | **Any exposure** | | | | **Any Concurrent Exposure** | | | |
| | ***col %*** | ***(n)*** | ***row %*** | ***(n)*** | ***OR*** | ***(95% CI)*** | ***row %*** | ***(n)*** | ***OR*** | ***(95% CI)*** |
| **Overall** | | (1,885) | 47.5 | (896) | -- | -- | 37.1 | (699) | -- | -- |
| **Partner factors** | | | | | | | | | | |
| **Race/ethnicity** | | | | | | | | | | |
| White non-Hispanic | 61.1 | (1152) | 45.0 | (518) | *ref.* | | 35.0 | (403) | *ref.* | |
| Black non-Hispanic | 19.8 | (373) | 55.0 | (205) | 1.49 | (1.18, 1.89) | 41.8 | (156) | 1.34 | (1.05, 1.70) |
| Hispanic | 19.1 | (360) | 48.1 | (173) | 1.13 | (0.89, 1.44) | 38.9 | (140) | 1.18 | (0.93, 1.51) |
| **Age** | | | | | | | | | | |
| < 25 | 38.5 | (718) | 47.6 | (342) | *ref.* | | 35.4 | (254) | *ref.* | |
| 25 – 29 | 21.7 | (405) | 48.6 | (197) | 0.86 | (0.68, 1.10) | 37.0 | (150) | 1.08 | (0.84, 1.38) |
| 30 – 39 | 22.6 | (421) | 43.9 | (185) | 1.04 | (0.82, 1.33) | 37.1 | (156) | 1.08 | (0.83, 1.38) |
| 40+ | 17.3 | (322) | 50.0 | (161) | 1.10 | (0.85, 1.43) | 40.4 | (130) | 1.24 | (0.94, 1.62) |
| **Partner type** | | | | | | | | | | |
| Main | 52.4 | (985) | 28.9 | (285) | *ref.* | | 21.5 | (212) | *ref.* | |
| Casual | 47.6 | (893) | 68.3 | (610) | 5.29 | (4.35, 6.45) | 54.5 | (487) | 4.37 | (3.58, 5.35) |
| **Location met** | | | | | | | | | | |
| Offline | 50.8 | (957) | 44.5 | (426) | *ref.* | | 36.4 | (348) | *ref.* | |
| Online | 49.2 | (927) | 50.7 | (470) | 1.28 | (1.07, 1.54) | 37.9 | (351) | 1.07 | (0.88, 1.29) |

[1] Excludes 121 of 2,004 UAI partners for whom UAI data on other partnerships of the same participant are insufficient for indirect exposure calculations.

**Table 3**

Multivariable models of the relationships between partner race/ethnicity and type with indirect exposure

| # | Model exposure outcome | Adjusted for repeated measures | Partner race/ethnicity | | | | | | Partner Type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Black vs. White | | | Hispanic vs. White | | | Casual vs. Main | | |
| | | | *adj.OR* | *(95% CI)* | *p* | *adj.OR* | *(95% CI)* | *p* | *adj.OR* | *(95% CI)* | *p* |
| **1a** | Any exposure | N | 1.34 | (1.09, 1.65) | 0.005 | 1.26 | (1.02, 1.56) | 0.03 | 5.34 | (4.52, 6.30) | < .0001 |
| **1b** | Any exposure | Y | 1.34 | (1.11, 1.61) | 0.002 | 1.28 | (1.07, 1.53) | 0.007 | 3.62 | (3.14, 4.18) | < .0001 |
| **2a** | Any concurrent exposure | N | 1.07 | (0.90, 1.28) | 0.43 | 1.14 | (0.95, 1.37) | 0.17 | 3.73 | (3.23, 4.32) | < .0001 |
| **2b** | Any concurrent exposure | Y | 1.03 | (0.90, 1.18) | 0.68 | 1.08 | (0.96, 1.22) | 0.18 | 1.97 | (1.76, 2.20) | < .0001 |
| **3a** | Any UAI exposure | N | 1.42 | (1.10, 1.84) | 0.008 | 1.14 | (0.87, 1.48) | 0.92 | 5.32 | (4.35, 6.49) | < .0001 |
| **3b** | Any UAI exposure | Y | 1.37 | (1.10, 1.72) | 0.006 | 1.02 | (0.81, 1.29) | 0.87 | 3.04 | (2.52, 3.67) | < .0001 |
| **4a** | Any concurrent UAI exposure | N | 1.28 | (0.99, 1.66) | 0.06 | 1.22 | (0.93, 1.58) | 0.15 | 4.37 | (3.57, 5.36) | < .0001 |
| **4b** | Any concurrent UAI | Y | 0.99 | (0.78, 1.27) | 0.96 | 1.18 | (0.99, 1.40) | 0.06 | 1.99 | (1.68, 2.35) | < .0001 |