

CONCURRENT SEXUAL PARTNERSHIPS:  
PREDICTORS OF INITIATION AND RELIABILITY OF REPORTS

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment  
of the requirements for the degree of Doctor of Philosophy in the  
Department of Epidemiology in the Gillings School of Global Public Health.

Chapel Hill  
2015

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## **ABSTRACT**

Diana Maria Sanchez: Concurrent Sexual Partnerships: Predictors of Initiation and Reliability of Reports.  
Analysis of the Project on Partner Dynamics.  
(Under the direction of Victor J. Schoenbach)

Concurrent sexual partnerships contribute to STI/HIV transmission. STI/HIV risk may differ depending upon the circumstances and motivations surrounding concurrency. Greater understanding of motivations for concurrency initiation may assist prevention programs. However, most concurrency studies are cross-sectional, which limits ability to be certain which factors preceded concurrency initiation. Also, concurrency is a function of relative timing of when partnerships begin and end. But do people accurately report the dates on which they had sexual intercourse? For example, memory failure and imprecision can compromise the accuracy of reported dates, with implications for STI/HIV research and control programs.

The Project on Partner Dynamics (POPD) interviewed 536 young adults and 151 of their sexual partners. The 536 index participants were recruited from Los Angeles area community sites and interviewed every 4-months about perceptions and behaviors. At 8- and 12-months, index participants brought a partner for interview ("partner participant"). The 151 unique index-partner dyads were interviewed separately and jointly about partnership dates. Poisson regression models using generalized estimating equations (GEE) estimated the association between perceived partner non-monogamy (PPNM) and concurrency initiation (incidence). We also compared index and partner participants' reports of dates of first and last sex to estimate inter-partner agreement (IPA), and used linear regression to model the log of the differences.

At 4-, 8-, and 12-month interviews, 4-month concurrency incidence was 8.5%, 10.6%, 17.8%, respectively. Participants with recent PPNM were more likely to initiate concurrency (crude risk ratio (RR)=4.6; 95%CI=3.0, 7.0; adjusted RR=4.0, 95%CI=2.6, 6.1). IPA (within 30 days) was low-to-moderate for first sex (43.1%), and high for last sex (94.5%). For both first and last sex dates and within each dyad:

participants who were female (54.7% vs. 45.3% for first sex; 62.5% vs. 37.5% for last sex), had fewer sex partners (58.5% vs. 41.5% first sex; 54.8% vs. 45.2% last sex), or had greater commitment (56.3% vs. 43.7% first sex; 52.2% vs. 47.8% last sex) were in more agreement with joint dyad reports.

PPNM and concurrency are associated, and at least in many cases, PPNM precedes concurrency initiation. Methods that increase reporting accuracy for partnership dates could improve concurrency research.

## **ACKNOWLEDGEMENTS**

This dissertation is the product of years of guidance and collaboration, and I have many to thank.

First, this work would not have been possible without the tireless support of my dissertation chair and advisor, Victor Schoenbach. Dr. Schoenbach (“Vic”) has provided thoughtful mentorship in every aspect of the dissertation, and has been a true champion of this work. He has been incredibly generous with his time and wisdom, and – at each stage of the dissertation, from initial development to final presentation – treated me as a fellow Epidemiology colleague, while challenging me to apply what I have learned in coursework and experience. Although I did not keep an exact count, I can confidently say that Vic and I have spent hundreds of hours together in consultation, editing, and discussions. Vic makes a profound investment in each one of his students’ academic, personal and professional development, and it has been my sincere privilege to be one of his advisees.

I would also like to thank my committee members –Charles Poole, Marie Harvey, Adaora Adimora, and Peter Leone – for their expert support and guidance, and their instrumental feedback on analysis and interpretation.

These analyses are the product of a collaboration between the University of North Carolina at Chapel Hill and those from Oregon State University and Purdue University, who developed and managed the Project on Partner Dynamics (POPD) study. I owe a large debt of gratitude to the Principal Investigators of the POPD study, Marie Harvey and Chris Agnew, for generously allowing me to use their data for these analyses, and to Vic – for fostering collaboration with this group. The POPD study members – Marie Harvey, Chris Agnew and Jocelyn Warren – were incredibly supportive and helpful with each stage of the analyses, and I owe my sincerest thanks to them.

These analyses were generously supported by the National Institutes of Health, which funded the original POPD study and its continued analyses as well as a pre-doctoral fellowship which supported my doctoral training.

I would also like to offer my sincerest thanks to my family and friends, especially: my husband, Adam, for his patience, encouragement and listening ear through every phase of my doctoral training; my mother, MariCeli, who completed her own doctorate degree as I entered mine, and acted as a role model as I pursued my own degree; my father, who has always cheered me on in my education; my siblings, Sara and Julio David, for offering their love and humor at each step of my doctoral training; and my other wonderful family members and friends for their wisdom, counsel, and support.

I thank you all. Without your support, I simply could not have completed my doctoral training and dissertation.

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## **LIST OF ABBREVIATIONS**

STI	Sexually transmitted infections
STD	Sexually transmitted diseases
HIV	Human Immunodeficiency Virus
PPNM	Perceived partner non-monogamy
POPD	Project on Partner Dynamics
IPA	Inter-partner agreement
AOD	Alcohol or other drug use
RR	Risk Ratio
PR	Prevalence Ratio
CI	Confidence Interval

## CHAPTER 1: CRITICAL REVIEW OF THE LITERATURE

### Concurrent Sexual Partnerships

Concurrent sexual partnerships, or partnerships which overlap in time, alter the structure of sexual risk networks and may facilitate the spread of sexually transmitted infections<sup>1-5</sup>. In a mathematical model, Morris and Kretzschmar demonstrated that concurrent sex partnerships increase the transmission of HIV through a population.<sup>5</sup> Epidemiologic studies have suggested concurrency to be associated with increased rates of HIV, syphilis, chlamydia, gonorrhea and Human papillomavirus (HPV) infection among various populations in the United States.<sup>1,3,5-10</sup> In fact, it has been suggested that characterization of sexual partnership overlap, versus the number of sex acts or sex partners alone, may be a more meaningful correlate of STI/HIV risk in certain sexual networks.<sup>10</sup>

### Concurrent Sexual Partnerships: High-risk Groups

For a variety of social and behavioral reasons, concurrent sex partnerships may be common among racial/ethnic minority groups as well as young adults.<sup>3,6-8,11-15</sup> In a study examining concurrency patterns among adolescent STD clinic attendees aged 14-19 years, sex partner concurrency in the last 6 months was widespread at nearly 45% and also associated with having chlamydia and gonorrhea.<sup>6</sup> In a study of partnerships among those aged 18-25, Gorbach *et al.* found that 26% of partnerships had one or both partners involved in concurrent sexual relationships, and that partnerships in which one or both partners were concurrent were nearly 4 times as likely to report an STI diagnosis<sup>16</sup>. Using nationally representative data from the 2002 National Survey on Family Growth (NSFG), Adimora and colleagues found that about 11% of men<sup>11</sup> about 6% of women<sup>14</sup> had a concurrent partnership in the previous 12 months. Concurrency was associated with racial/ethnic minority status, age under 30 years, early age at first intercourse, and substance use. Javanbahkt and colleagues found that concurrency among African American, Hispanic and Asian women was common and associated with risk of Human Papillomavirus (HPV) infection.<sup>8</sup> Sexual partner concurrency may in part account for disproportionately high STI rates

among young adults and racial/ethnic minorities. Understanding the factors associated with initiating concurrent sexual behavior is an important step in reducing STI rates in these populations.

### **Motivational Factors in Initiating Concurrent Sexual Partnerships**

Gorbach *et al.* (2002) identified six distinct concurrent partnership types in regard to underlying motivations: reciprocal, reactive, compensatory, transitional, separational, and experimental.<sup>17</sup> The different types are associated with different STI/HIV risk profiles, network configurations, and STI/HIV risk.<sup>15,17-19</sup> We hypothesize perceived partner non-monogamy (PPNM) – the belief that a sex partner has additional sexual partners outside their sexual relationship – to be associated with concurrency, including the initiation of *reactive* concurrency. As described by Gorbach, reactive concurrent partnerships may be initiated following awareness of a partner's involvement in other relationships (i.e., perceived partner non-monogamy), motivated by the desire to establish fairness in the relationship and feelings of jealousy.<sup>17</sup> Reactive concurrent partnerships are often deliberately casual in nature, and as a result, are associated with higher risk.<sup>15,17</sup>

Cross-sectional associations between PPNM have been previously observed in both quantitative,<sup>14,15,20</sup> and qualitative studies.<sup>17,19</sup> In a qualitative study of STD clinic attendees by Senn *et al.*, participants identified PPNM was a likely motivator of initiating concurrency, either because PPNM signaled a degradation of relationship trust, or out of retaliation.<sup>19</sup> Gorbach and colleagues found that 13% of partnerships involved both partners' reported concurrent sexual behavior.<sup>16</sup> Adimora and colleagues found that men and women reporting a non-monogamous partner in the past year were, respectively, 13 and 23 times as likely to have concurrent partnerships themselves.<sup>11,14</sup> A 2012 study by Hess and colleagues found that 34% of young adults samples reported engaging in reactive concurrency ever, and found that reactive concurrency was associated with high-risk behaviors such as drug use.<sup>15</sup> Additionally, a study by urban young adults in Kenya led by Xu *et al.* found that reported partner non-monogamy was associated with hazard ratios of 2.1 for females and 2.5 for males.<sup>20</sup> However, because these findings are based on cross-sectional data, it is not known whether the association of concurrency with partner non-monogamy reflects a shared understanding of non-exclusivity in the relationship or whether one partner's concurrency arises in response to the other's.



Elucidating the social and behavioral motivations for initiating concurrency may provide valuable information for crafting STI/HIV prevention messages, particularly for high-risk groups.

### **Quality of Sexual Partnership Histories**

Dates of sexual partnership are frequently collected in STI research – such as studies of concurrency, gap length and duration – as well as STD control programs, such as contact tracing. Concurrency can be measured through direct query (e.g., “Have you had sexual intercourse with one partner while involved in a sexual relationship with another?”). A second method for capturing concurrency, recommended by the UNAIDS Reference Group,<sup>21</sup> involves comparing dates of first and last sexual intercourse with different partners. The two approaches differ in the demands placed on participants and result in overlapping but not identical classifications of concurrency. Comparison of dates is a common method since participants do not need to explicitly acknowledge stigmatized partnering patterns, but people’s ability to report the starting and ending dates of their sexual partnerships has not been established.

Retrospective self-report of partnership dates is subject to memory failure, stigma, social desirability bias and imprecision.<sup>9,22-30</sup> The extent to which these errors affect the estimation of concurrency is unclear. The quality of measurement is critically important in concurrency research<sup>18</sup> as well as STD control programs, such as contact tracing.

In principle, measurement quality can be subdivided into (1) agreement or repeatability (whether the same result is obtained when a measure is repeated) and (2) validity (whether the result accords with the true value). In practice, however, these two dimensions are often difficult to separate, since there is generally no way to ascertain the true value. For example, if a respondent is asked the date (s)he began a sexual partnership and then later is again asked the date (s)he began that partnership, agreement between the two responses is regarded as indicating agreement if the measures are considered to have comparable opportunity for validity or as indicating validity of the later response if it came several years after the first, especially if the first response was close in time to the date in question. Agreement between partners’ independent reports of the date does not establish the date’s validity but provides greater assurance than does agreement between responses on two occasions from one of the partners alone.

Thus, in practice, investigators may assess agreement as a surrogate for validity, by measuring the extent of agreement and interpreting it according to relative confidence in the measures being compared.

### **Factors Associated with Agreement and Reliability**

Existing research has found that reliability and agreement of reported sexual behavior are lower among those with multiple sex partners,<sup>31</sup> in non-monogamous relationships and in non-marital relationships.<sup>32</sup> These findings suggest that data on concurrent sexual partnerships are more susceptible to error than data on non-concurrent partnerships. Research specifically focusing on the quality of concurrent sex behavior measurement is limited, and several gaps exist. Notably, the focus of studies examining the quality of sexual partnership data has been on measures such as sex frequency or number of sex partners. Information on the agreement and validity of individuals' recall of information used to establish concurrency, such as dates of sexual activity, is extremely limited.

### **Limitations of Reliability and Agreement Studies**

Few studies have examined partnership-level agreement on time-related characteristics of sexual partnerships, such as dates of sexual activity. Dates of first and last sex are commonly used to define sexual risk exposures such as concurrency and are implicit in questions about the number of partners in a time interval (e.g., the past three months). Brewer and colleagues (2006) found moderate agreement in partner reports of date of first sexual intercourse among 774 sexual dyads: 56% agreed to the exact date, an additional 32% agreed on the month, and an additional 12% agreed on the year.<sup>22</sup> This study also found that dyads identified through HIV partner tracing provided less reliable reports. However, in a sensitivity analysis based on simulations, the authors found that the observed level of misclassification did not yield meaningfully different categorization of concurrent sexual partnerships. These findings suggest moderate interpartnership agreement overall, but that those most at risk for HIV/STI may provide systematically less reliable reports on concurrency-relevant information such as dates. However, several aspects of the study may have influenced the findings. Brewer and colleagues<sup>22</sup> studied a sample of dyads asked to recall sexual behavior over periods ranging from 180 days to 1 year. Additionally, index and partner participants were interviewed up to 2 months apart, reducing comparability between their reports. To the extent that relationship dates are important for defining concurrency, the assessment of

partner agreement is essential to establishing a margin of error for concurrency estimates and for identifying predictors of greater reporting error.

Comparing partners' individual reports of their dates of first and last sex to dates reported when partners are interviewed as a joint dyad provides an additional opportunity to investigate agreement and potential validity. Joint dyad interviewing has shown utility in psychological research on family, marriage and cognition.<sup>33-36</sup> Joint dyad interviewing allows partners to remind each other about information relevant to recall, to discard false information, and to corroborate each other's recall.<sup>33-35,37</sup> As a result, joint dyad interviews may provide a better source of data than one partner's recall of events or behavior.<sup>34,35</sup> Comparing joint reports to individual recall in dyads, Harris and colleagues (2012) found that while joint reporting led to decreased completeness of recall (e.g., leaving information out of reports), it also led to improved agreement of data recalled (i.e., "collaborative consensus").<sup>35</sup> However, joint dyad interviewing can be affected by relative power and influence within partnerships,<sup>35</sup> leading to "collaborative inhibition", which may be problematic for measuring value-laden behaviors such as condom use and private information such as relationship satisfaction, since a respondent may be constrained when expressing individual opinions and beliefs in the presence of the partner. For less stigmatized behaviors or less sensitive data such as dates, however, group-level information may represent a more nearly valid data source.

## **Summary**

Various studies have found associations between concurrency and STI/HIV risk.<sup>1,3,5-10</sup> Qualitative and cross-sectional research has also suggested that different motivations for being involved in concurrent sexual partnerships may be associated with varying degrees of STI/HIV risk.<sup>15,17-19</sup> In specific, concurrency motivated by a partner's non-monogamy is thought to be higher risk than other types of concurrency.<sup>15,17,20</sup> However, to date, concurrency research has used cross-sectional research, and thus factors associated with concurrency initiation are unknown.

Retrospective dates are frequently collected in STI research – such as studies of concurrency, gap length and duration – and STD control programs, such as contact tracing. Reporting of dates poses significant cognitive demands on participants, and is subject to known methodological challenges such as imprecision, memory failure and social desirability bias.<sup>9,22-30</sup> The quality of reported dates of sexual

partnership dates remains unclear, as does the extent to which potential imprecision affects measurement related to sexual partnerships. Opportunities for assessing quality of dates arise from comparisons of two partners within a dyad, as well as comparing individual dyads to a joint dyad measure, which – due to processes of collaborative recall and corroboration – may present a more nearly valid source of information.<sup>33-35,37</sup>

## CHAPTER 2: SPECIFIC AIMS AND HYPOTHESES

Though a substantial body of literature supports the association between concurrent sexual partnerships and risk of STI/HIV,<sup>1,3,5-10</sup> little is known regarding factors involved in the initiation of concurrency or the quality of concurrent sexual partnership data. Previous findings on concurrent sexual behavior have been based on cross-sectional data and, as a result, factors involved in the initiation of concurrency are unclear. Further, retrospective self-report of partnership dates are widely used in STI research and STD control, but are subject to methodological challenges, including memory failure, imprecision and recall bias.<sup>29,31,38,39</sup>

Knowledge about predictors of concurrency initiation may provide insights into STD and concurrency reduction programs, particularly among at-risk groups such as young adults and racial/ethnic minorities. Additionally, few studies have assessed the quality of sexual partnership data, and the extent to which these methodological challenges affect measurement remain unclear. Information on the quality of sexual partnership dates has important implications for STI research (e.g., studies of concurrency, gap length and duration) as well as STD control programs using dates of intercourse (e.g., partner notification).

We analyzed data collected by the Project on Partner Dynamics (POPD), a one year longitudinal study of 536 young adults in the Los Angeles area during 2006-2009. These data were used to examine the association between perceived partner non-monogamy and initiation of concurrent behavior, as well as the validity of sexual partnership dates within dyads.

The aims of this analysis were to:

1. Estimate the association between the belief that one's partner has another sexual partner (perceived partner non-monogamy) and initiation of a concurrent partnership during the following 4 months.
2. Evaluate agreement between sexual partners' reports of the dates of their first and last sexual intercourse.

- 2a. Estimate the percent agreement of reported dates of first and of last sexual intercourse within sexual partnerships (i.e., comparing index and partner participants' responses)
- 2b. Compare individual partner reports for dates of first and last sex with those obtained in a joint dyad interview
- 2c. Identify factors associated with agreement between individual and joint dyad responses

## Hypotheses

Hypotheses were informed by a critical review of the literature and defined *a priori*.

For each aim, the hypotheses were as follows:

Specific Aim 1: Estimate the association between the belief that one's partner has another sexual partner (perceived partner non-monogamy) and initiation of a concurrent partnership during the following 4 months.

### *Hypothesis:*

- A. Perceived partner non-monogamy predicts the index partner's initiation of a concurrent partnership during the following 4 months.

Specific Aim 2: Evaluate agreement between sexual partners' reports of the dates of their first and last sexual intercourse.

### *Hypotheses:*

- A. In inter-partner analyses, partnerships with larger age differences and/or substance abuse will tend to have lower accuracy for reporting dates.
- B. In dyad agreement analyses, dates provided in joint dyad interviews will tend to match the original report of index or partner participants, rather than represent an intermediate value between index- and partner-reported dates.

## CHAPTER 3: ANALYTIC APPROACH

### **Project on Partner Dynamics (POPD) Study**

Analyses were conducted on data from 536 index participants and 151 sex partners of index participants (“partner participants”) from the Project on Partner Dynamics (POPD) study, a longitudinal study of heterosexual men and women aged 18-30 in the Los Angeles area. The primary objective of POPD was to examine the influence of heterosexual relationship dynamics on sexual risk perceptions, intentions, and behaviors. The study tracked a racially and ethnically diverse sample over one year as they initiated, maintained and/or terminated sexual relationships.

#### POPD Recruitment

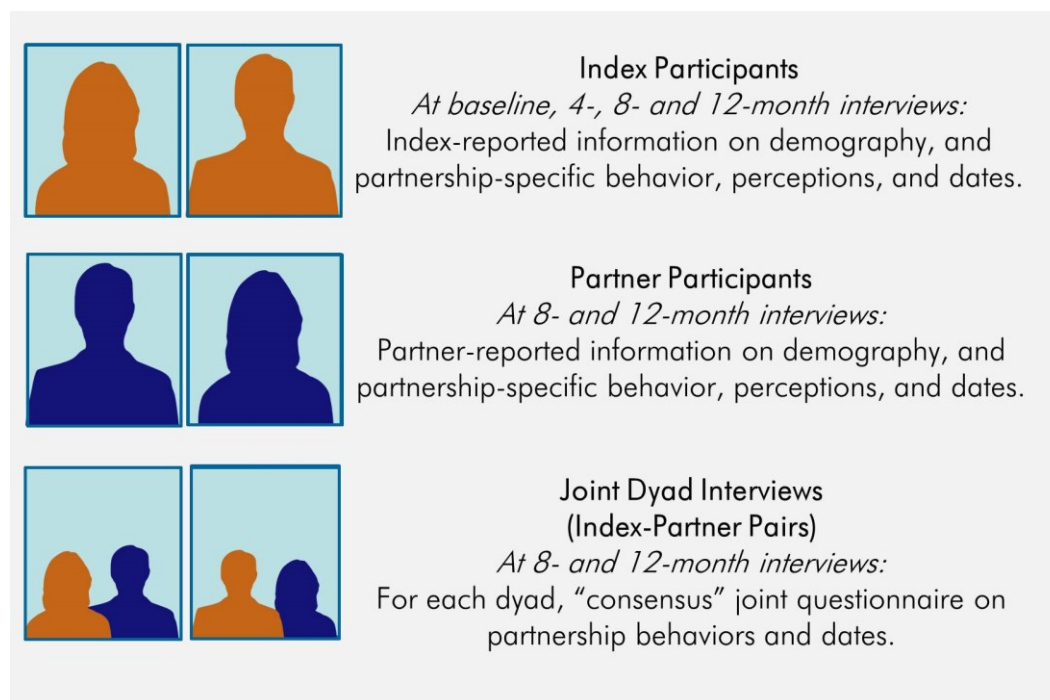
Participants were recruited from community locations, including: STD clinics, family planning clinics and community organizations. Eligibility criteria were: 1) age 18-30 years; 2) unprotected sex in the previous three months; and 3) any of the following: (a) multiple sexual partners in the past year, (b) STI treatment in the past 2 years, (c) ever having injected drugs, or (d) having had a sex partner who was (for women only) a man who had sex with men, who used injection drugs, who was HIV+, who had been exposed to an STI during the past year, whom the participant believed had sex with someone else during the past year, or whom the participant suspects may have sex with someone else in the next year (while still in the relationship with the participant). The POPD study excluded anyone who was HIV+ (by self-report), not fluent in either English or Spanish, or who anticipated moving from the area within the next year. Participants were interviewed in their preferred language.

#### POPD Interviews

Participants recruited at baseline (“index” participants; N=536) were interviewed, in private, at baseline, 4-, 8- and 12-months by a sex- and race/ethnicity-matched interviewer using a laptop computer. During each survey, participants were asked to recall sexual behavior and relevant information in the recall interval, which was the preceding 4 months at baseline interviews, and since the last interview at 4-,

8- and 12-month interviews (median of 4-months between interviews) (Figure 3.1). Each interview asked specific information about each of the participant's sex partners, identified by initials or nickname, during the recall interval. For sensitive questions, participants had the option of entering answers to directly into the computer themselves.

In scheduling 8-month interviews, POPD field staff asked participants if they had a current sex partner (age 18 years or older) they were willing to ask to participate in POPD. Index participants were invited to bring only one current sex partner ("partner participant") to interview. If a partner was recruited, the index and partner participants were interviewed separately about demographic characteristics, risk behaviors, and relationship-specific perceptions, behaviors and beliefs. The index participant and accompanying partner participant were then invited to participate in the joint dyad interview, in which both participants completed a short survey together. Joint dyad surveys collected the dyad's joint responses for 23 questions, which included: dates of partnership, frequency of sex, alcohol and other drug use before or during sex, contraceptive and safer sex behaviors and intentions, and dyadic power (Figure 3.1). At 12-months, index participants were again invited to bring their partners for interview. If a sex partner was not recruited, index participants were interviewed alone.



**Figure 3. 1: Sources of Partnership Data in the Project on Partner Dynamics, 2006-2009.**



## Data Management and Cleaning

Data for POPD consisted of the following data sources: administrative records for baseline and each follow-up interview (i.e., records of unique index and partner participant IDs and dates of interview), index participant questionnaire data for baseline and each follow-up, partner participant questionnaire data for 8- and 12-month interviews, and joint dyad questionnaire data for 8- and 12-month interviews (Figure 3.1). Data management and cleaning steps were taken to ensure that the data were in an appropriate format to identify errors and clean data (e.g., errors in sexual partnership dates, or with linking index and partner participants), and in the necessary format for analyses (e.g., re-shaping the dataset for analysis and modeling).

### Aim 1: Missing Sexual Partnership Data, Exclusions and Logic Checks

For each partnership, we identified missing, out-of-range and seemingly erroneous dates. We identified a total of 18 unique types of errors, which fell under the following five categories: 1) reported date of last sex came after interview date; 2) reported date of last sex was in previous recall period; 3) reported date of last sex came before date of first sex; 4) first and/or last dates of sex missing; and 5) other errors (Table 3.1). For each, a rationale for how to proceed was based on UNAIDS guidelines,<sup>21</sup> where applicable, or by consensus of POPD researchers. Data management steps used in these analyses were similarly adopted in other analyses of POPD data.<sup>40</sup>

In cases where the date of first or last sex was missing, or date of last sex came before date of first sex, we set first and last sex dates in that interval to be equal to each other unless the frequency of sex was 0, in which case we excluded the partnership. In cases where dates of first or last sex reported were later than the interview date: if the problem was an apparent error in reported year, we corrected the year; otherwise, we excluded partnerships if frequency of sex was 0. If the frequency of sex was greater than 0, we set the date of last sex to the first date in the recall interval (i.e., the day after the previous interview). Additionally, we excluded 8 partnerships which were not ongoing at the baseline interview but were subsequently re-initiated during the course of the study, because of uncertainty about whether the partnership was active between the first and last intercourse dates available and the concern that including these partnerships might artificially inflate concurrency estimates. In total, we identified 420 errors among the 3,030 partnership records reported by index participants over the course of the study.

We corrected or imputed values for 285 of the errors, and excluded records for 135 of the errors (32% of all errors; <5% of total partnership data).

#### Aim 2: Merging Sexual Partnership Information

We analyzed data from index, partner and joint dyad interviews where there was sufficient information to link index and partner participants, and where at least one comparison in reported dates could be made for either date of first or last sex (i.e., index vs. partner; partner vs. dyad; or index vs. dyad). There were 5 instances where index participants were partner participants in another interview, and vice versa. To avoid duplicate comparisons, in these situations, we included only one set of interviews for each unique index-partner pair: in cases where one of the partners was recruited into the POPD study earlier (4 out of 5 cases), we used the record corresponding to the index participant who was interviewed earliest; in cases where both persons in the dyad were recruited as index participants on the same day (1 out of the 5 cases), we used the record corresponding to the partner participant that was recruited into the study earlier.

**Table 3. 1: Frequency and Handling of Errors in Reported Sexual Partnership Data from Index Participants Enrolled in the Project on Partner Dynamics**

Error Pattern	Example Cause(s)	Frequency
Reported date of last sex came after interview date	Due to discrepancy in interview date, apparent typo in date of last sex, or else, no obvious reasons.	86
Reported date of last sex was in the previous recall period	Due to not being an active sexual partnership at the time of the interview.	111
Reported date of last sex came before reported date of first sex	Non-sequential dates of sex due to apparent typos in year of partnership.	31
Dates of sexual activity are missing	Due to not being an active sexual partnership at the time of the interview, or skipping the question.	56
Other errors	Inconsistent partnership names or numbers, non-sequential dates of last sex between one interview and another, or non-sequential interview dates.	136

## Aim 2: Missing Sexual Partnership Data, Exclusions and Logic Checks

We identified missing, out-of-range and seemingly erroneous dates by examining interview dates, dates of first and last sex from index and partner participants, and dates of first and last sex from joint dyad interviews. For all data management steps, we corrected errors found within one source of data (i.e. data within just one interview) because: 1) using multiple sources of data to clean data would limit our ability to interpret agreement in the context of routinely collected data, as only one source of data is available in most research and practice settings; and 2) using multiple sources to correct data could bias agreement estimates, making agreement higher than it was.

If a date of first or last sex fell after the date of interview, as confirmed by administrative records, we excluded the date from analysis unless it appeared to be a recall or transcription error in the year. Altogether, a total of 12 corrections and edits were made: 10 to dates of sex (approximately 1% of all date information used in analyses) and 2 to interview dates.

## **Outcome Measures**

### Prevalent and Incident Concurrent Sexual Behavior

When identifying concurrency by comparing dates of partnership, the UNAIDS Reference Group on Estimates, Modelling, and Projection guidelines suggest utilizing a relatively short period of recall (6 months).<sup>21</sup> Those reporting no overlapping sexual partnerships in the past 4 months were classified as not having been concurrent in the past 4 months (=0). If the overlap in two partnerships was greater than one day, we classified them as concurrent due to overlap in dates in the past 4 months (=1). If the overlap in two partnerships was less than one day (e.g., reported last sex date of one partnership was identical to the first sex date of another partnership), we assumed that these are reflective of a dissolution-initiation pattern rather than concurrency, and coded them as non-concurrent as measured by date overlap (=0).

Those missing dates for all partnerships in the past months were coded as missing (.). As per UNAIDS guidelines on defining concurrency:<sup>21</sup> if a respondent reported was missing first or last date of sex (i.e., they reported either first or last sex date, but not both), and reported having sex only once with a partner, then the date of first and last sex were set to be equal. The comparison in date overlap was then performed, as outlined above.

Participants with insufficient data to be classified definitively as missing all dates of partnerships, concurrent due to overlap (=1) or non-concurrent due to overlap (=0) were included as missing data.

For each recall period (approximately 4 months), prevalent concurrency was defined dichotomously as an overlap in time between two or more partnerships during the recall period, based on self-reported dates of first and last intercourse. Participants lost to follow-up or missing partnership data were excluded. Concurrency was classified as incident if the participant was not concurrent (i.e., no prevalent concurrency) during the previous recall period. To ensure accuracy, concurrency was identified independently by visual review and with a Stata program developed by POPD researchers Isaac Washburn (Oklahoma State University) and Jocelyn Warren (Oregon State University). All cases of inconsistency between visual review and the Stata algorithm were then reconciled by the POPD study team by manually reviewing partnership records.

#### Absolute Differences between Index and Partner-Reported Dates

For each dyad, dates of first and last sex were collected through: (1) separate interviews of index participant and partner participants; and (2) a joint dyad interview in which index participants and partner participants completed a questionnaire together (Figure 3.1). During separate interviews, index and partner participants were asked about all sex partners in the past 4 months. For each reported sex partner, dates of first and last sexual encounter were ascertained by the questions: “*What was the date of the first time you had sex with [PARTNER]?*” and “*What was the date of the last time you had sex with [PARTNER]?*”.

We assessed inter-partner differences in report by comparing dates of first and last sexual encounters as reported by the index and partner participant. To do so, we calculated the absolute number of days between reported dates of first and last sex, as well as the mean, median and 75% quartile of absolute differences.

In addition to comparisons between index and partner reports, we compared each partner's report of date of first sex in a partnership to the dyad's report from the joint dyad interview. In joint dyad interviews, dyads were asked, “*What is the date of the first time you had sex with one another?*” and instructed to agree upon the day, month, and year. Based on previous research on joint dyad interviewing, we expected the joint dyad responses to more closely reflect the actual dates, as the two

participants—who were instructed to discuss their responses and thought-process out loud—could help each other recall specific details related to the initiation of their sexual partnership.<sup>33-37</sup>

#### Inter-Partner Agreement (IPA)

We used inter-partner absolute differences to create a percent agreement measure. Among partnerships where two values for first and last sex were non-missing: agreement to the day reflected those for whom date of first and last sex match, to the day; agreement within 30 days reflected those for whom date of first and last sex match in terms of being within 30 days of each other (example: July 1, 2007 and May 28, 2007 would be considered to agree within 30 days); agreement within the calendar year reflected those for whom date of first and last sex are precise in terms of being within the same year (example: January 1, 2007 and January 17, 2007). Similarly, agreement to within 7-, 14-, 30-, 90-, 180-, and additionally for first sex only, 365- days, were calculated.

#### Dyad Agreement

We examined characteristics of participants who had more agreement with joint dyad reports by comparing dates of sex reported by index and partner participants to those from joint dyad interviews. For each dyad, we identified which of the two participants had more agreement with joint dyad reports in terms of: age (older vs. younger participant); sex (male vs. female participant); role in study (index vs. partner participant); number of sex partners in lifetime (greater vs. fewer); relationship commitment (more vs. less, as reported as a subset of the Investment Model Scale<sup>41</sup>); and power (more vs. less relationship power, as decided by the dyad in the joint dyad interview).

Additionally, to estimate magnitude of disagreement within each comparison, we estimated mean absolute differences, in days, between the date reported in the dyad interview and the date reported by dyad participants with that characteristic (e.g., female partners, older partners, etc.). We estimated means as a simple summary of distances and to facilitate comparison with previous studies. Particularly for dates of first sex, however, means were strongly influenced by outliers. We therefore summarized difference distributions with medians and upper quartiles (i.e., 75th percentile), thereby providing a bound for the great majority of observations and a more robust summary of the extent of large disagreement.

## Covariates

### Perceived Partner Non-Monogamy (PPNM)

In the POPD study, perceived partner non-monogamy was collected for each active, reported partnership at each interview; those who reported a break-up with a partnership were not asked about perceived partner non-monogamy, as this perception might be highly influenced by the break-up and unreliable.

For each active sex partner, the original question in the study asked respondents: “Which of these statements best describes your sexual relationship with [Partner Name]?” Possible responses were coded on a 5-point scale, detailed in the following table:

**Table 3. 2: Perceived Partner Non-Monogamy Coding Scheme**

Original POPD Study Variable on Perceived Partner Non-Monogamy		Analysis Coding Scheme
Value	Corresponding Statement	PPNM Analysis Coding (Partnership- Level)
0	I am certain [Partner] has had sex with other people while involved with me.	1
1	I believe [Partner] probably has had sex with other people while involved with me.	1
2	I am not sure if [Partner] has had sex with other people while involved with me.	0
3	I believe [Partner] probably has not had sex with other people while involved with me.	0
4	I am certain [Partner] has not had sex with other people while involved with me.	0
5	(Not in original codebook, but there were 2 observations with this response; assume a mis-key of 4 or 7)	0
7	Don't know	0
8	Refuse to answer	0
.N	Not Applicable	.N

We hypothesized that perception of a partner's involvement in another sexual relationship (perceived partner non-monogamy, PPNM) may motivate the participant to initiate concurrency, such as in cases of reactive concurrency,<sup>17</sup> which we hypothesized occur relatively quickly. For each ongoing partner during each recall period, PPNM was coded dichotomously using information from the question, “Which of the following best describes your relationship with [partner]” (Table 3.2). A response “I am certain [partner] has had sex with others while involved with me” or “I believe he/she probably has had

sex with other people while involved with me” was coded as PPNM. Because of uncertainty about reporting accuracy, PPNM information was not collected for partnerships reported as terminated. Thus, at the participant-level, PPNM data was missing for participants who had no active partnerships at the time of the interview.

Perceived partner non-monogamy was not collected for terminated or broken-up partnerships, due to concerns about data quality and bias. However, there was a skip logic error at 4-month and 8-month interviews where those who reported break-ups were asked about perceived partner non-monogamy. As a result, for 166 partnerships and 27 unique subjects, perceived partner non-monogamy was assessed. These data are excluded in our modeling analysis, as it was the original intention of the study not to include data for these partnerships.

In the study, at all interviews after baseline, participants could have reported that they had no sex partners in the previous 4 months. (At baseline, they had to have sex partners to be included into the study.) We included a coding clause so that those who did not have any sex partners in the past 4 months (i.e., reported 0 sex partners, and had no partnership data) were coded as not having PPNM for that interval (e.g., PPNM=0). Additionally, during the process of data cleaning for the concurrency analysis, we manually designated some subjects as having no sex partners, if they did not have any usable sexual partnership date information, either due have out-of-range, seemingly erroneous or irreconcilable sexual partnership dates. For consistency in coding, those that had unusable concurrency data were coded as not having PPNM for the interview interval as well.

We coded PPNM as present or absent for each participant recall period, rather than in relation to specific partners, because concurrency that arises in response to PPNM need not necessarily involve the partner who was believed to be non-monogamous. In our statistical analyses we examined the relationships of concurrency with PPNM from the same recall period (“recent PPNM”; 0-4 months ago) and with PPNM from the preceding recall period (“distant PPNM”; 4-8 months ago).

#### Covariate: Relationship Commitment

We hypothesized that feelings of relationship commitment may influence one’s remembering of relationship events, including dates of intercourse. In the POPD study, relationship commitment was captured with a 7-question subset of questions from the Investment Model Scale.<sup>41</sup> This validated scale

includes seven questions assessing commitment (e.g., “*I want our relationship to last forever*” and “*I am committed to maintain my relationship with my partner*”), allowing Likert-type responses, ranging from 0 (do not agree at all) to 8 (agree completely). Relationship commitment was a 7-question subset of the Investment Model Scale, a 23-question inventory including questions of commitment, satisfaction, quality of alternatives, and investment size. The commitment subset of the Investment Model asked participants about their level of agreement with the following 7 statements:

1. “I want our relationship to last a very long time.”;
2. “I am committed to maintaining my relationship with my partner.”;
3. *Reverse-coded*: “I would not feel very upset if our relationship were to end in the near future.”
4. *Reverse-coded*: “It is likely that I will date someone other than my partner within the next year.”;
5. “I feel very attached to our relationship – very strongly linked to my partner.”;
6. “I want our relationship to last forever.”; and
7. “I am oriented toward the long-term future of my relationship (for example, I imagine being with my partner several years from now).”

Each question had a 9-point Likert scale (0 – 8), with higher responses (8 on a given question) representing more commitment, and lower scores (0 on a given question) representing lower commitment. (Note that statements 3 and 4 on the commitment sub-scale are reverse-coded.) The participant’s total commitment score was calculated as an average of non-missing responses.

In our dyad agreement analyses, the participant in the dyad with the higher score was coded as having “greater commitment” on the scale, and vice-versa. Dyadic power was collected during joint interviews with the question “*Thinking about one another, who do you think has more power in the relationship?*”, with possible responses including “*She does*”, “*Both of us, but more her*”, “*Both of us, but more him*”, or “*He does*”. We coded “*She does*” and “*both partners but more her*” as the dyad perceiving the female partner to have more power, and coded perception of power for males similarly.



#### Covariate: Relationship Power

In order to explore the effect of dyadic power on influencing the joint dyad response, we examined which participant in the dyad (the one perceived to have more vs. less power in the dyad) was more likely to provide dates of sex consistent with the joint dyad report. Dyadic power was collected during joint interviews with the question “*Thinking about one another, who do you think has more power in the relationship?*”, with possible responses including “*She does*”, “*Both of us, but more her*”, “*Both of us, but more him*”, or “*He does*”. We coded “*She does*” and “*both partners but more her*” as the dyad perceiving the female partner to have more power, and coded perception of power for males similarly.

#### Covariate: Gender

Males and females have been found to have different risks of both initiating concurrent behavior,<sup>3,14</sup> and in perceiving partner concurrency.<sup>11,19,42,43</sup> In statistical models, gender was coded with two dummy variables, one for “male” and another for “female”. We also included gender in our dyad agreement analyses, hypothesizing that, in heterosexual dyads, female versus male partners may provide individual responses which most similar to joint dyad reports.

#### Covariate: Age

We hypothesized that among young adults aged 18-30, age may be associated with both perceived partner non-monogamy and concurrency, such that younger persons are more likely to both perceive partner concurrency and initiate concurrent sexual behavior. We included age as a categorical variable in concurrency analyses, with dummy variables representing the following age ranges: 18-24, and 25-30.

#### Covariate: Race/ethnicity

Race and ethnicity have been found to be associated with reporting past concurrency.<sup>7,11,14,15</sup> Further, as qualitative reports have suggested that perceived partner infidelity was common among racially/ethnically diverse sample, we also hypothesized that minority race/ethnicity participants were more likely to perceive a partner’s concurrent behavior.<sup>19</sup> Race/ethnicity was included with dummy variables representing the following racial/ethnic groups: white non-Hispanic; black non-Hispanic; Latino/Hispanic and other race/ethnicity.

Covariate: Alcohol or other drug use before or during sex, past 4 months

Previous studies have found associations between substance use and reported concurrency<sup>11,14</sup> as well as agreement.<sup>44,45</sup> Alcohol or other drug (AOD) use with partners was assessed for each partner during each recall period with the question “*Thinking about the times you had intercourse with [Partner Name] during the past 4 months, did you use alcohol or other drugs before or during sex with them at any of those times?*”. Responses were dichotomous, and coded as either “Yes”, “No” or “I don’t know”.

In concurrency analyses (Aim 1), AOD was summarized dichotomously at the person-level (i.e., for each index participant, at each interview), with AOD use ever representing AOD use with any partnerships in the past 4 months (=1), and no AOD use (=0) representing those who reported no AOD use with all of their partners in the past 4 months.

In agreement analyses (Aim 2), we utilized dyad-specific responses for AOD use when modeling inter-partner agreement. Because we believe that engagement in AOD use by either index or partner participant could conceivably have an effect on agreement of reports, we coded AOD use within the partnership, so that either the index or partner participant reporting AOD before or during sex within the past 4 months was coded as having AOD at the partnership (=1); if both partners reported not using AOD before or during sex than, at the partnership-level, we coded no AOD use (=0).

Covariate: Age of sexual debut

Earlier age of sexual debut has been associated with concurrency.<sup>11,14</sup> We hypothesized that there may be an association between earlier age of sexual debut and partner’s non-monogamy. We chose the following categorical coding scheme, after considering the distribution of responses as well as the substantive rationale for addressing stages of development: ≤15 (young adolescence); 16-18 (middle adolescence), ≥18 (young adulthood). Each category for age of sexual debut was coded with dummy variables.

Covariate: Duration of partnership

Shorter duration of partnerships has been associated with greater agreement between dates,<sup>22,44</sup> as dates of sexual activity may be more recent. Duration of partnership was calculated as the time between the date of interview and the month of first sex, as reported by the index participant. Though we could have calculated duration based on either the index or partner participant’s date of first sex as a

reference point to calculate duration, we chose the index participant as the reference, because they were often asked about date of first sex prior to partner participant's recruitment, and therefore may have provided a more valid estimate of date of first sex, since it would have been ascertained closer to the event. We modeled duration of relationship in inter-partner agreement regression using a continuous variable.

#### Covariate: Recall interval

Brewer and colleagues found that the time between partner interviews (recall interval) affected inter-partner agreement on dates.<sup>22</sup> In the POPD study, although date of last sex was always assessed during the same interview date for index and partner participants, index and partner participants often had date of first sex ascertained at different interviews. Index participants were asked about date of first sex when they first identified the partner in an interview, which occurred as early as in baseline interviews. Partner participants, in contrast, were not asked about date of first sex with the partner until they were recruited into the POPD study by the index participant, up to 8-12 months after the index participant initially reported date of first sex.

Therefore, for analyses of inter-partner agreement of first sex, we included a variable on recall interval, which was calculated as the amount of time between when the partner participant's report of first sex was collected, and when the index participant's report of first sex was collected. In analyses of inter-partner agreement on dates of first sex, recall interval was initially coded with 3 dummy variables representing: 0 months between index and partner participant recall (i.e., first sex collected during same interview), 4-months between index and partner participant recall of first sex; and 8-12 months between index and partner participant recall of first sex. However, in the final analysis, we collapsed 8- and 12-months recall interval categories due to small numbers for 12-month intervals, as only 10 dyads fell into this category.

#### Covariate: Absolute age difference between index and partner

Age has been associated with inter-partner agreement on sexual health measures<sup>44</sup>, though data on the effect of age on inter-partner agreement of reported sexual partnership dates is limited. We hypothesized that greater differences in age between index and partner participants may be associated with disagreement on reported dates. In the POPD study, each participant was asked during separate

interviews to report their age with the question “*How old were you on your last birthday?*”. We calculated the absolute differences between index and partner participant’s reports. If either (or both) participant was missing information on age, we coded the absolute difference in age between participants to be missing.

Covariate: Agreement on frequency of sex, past 4 months

Dyads which agree on the frequency of sex have a higher likelihood on agreeing on the dates of sex<sup>22</sup>. During individual interviews, both index and partner participants were asked about frequency of anal and vaginal sex in the past 4 months with the question: “*How many times have you had vaginal or anal intercourse with [PARTNER] during the past 4 months?*”. We calculated the mean absolute difference of reported frequency of sex between index and partner, and used this continuous variable in inter-partner agreement analyses.

Covariate: Dyad monogamy

We hypothesized that a greater number of sex partners in the past 4 months may be associated with poorer recall within a dyad, and therefore lead to more inaccurate recall of dates. We used reported number of partners in the past 4 months as a surrogate for partnership monogamy, coding dyad monogamy status based on both index and partner participant’s reports of number of sex partners in the past 4 months from the interviews corresponding to when the partner participant was recruited (i.e., values from 8- or 12-month interviews). If an index or partner participant reported more than 1 sex partner in the past 4 months at the time of the interview, we coded that participant as being non-monogamous in the past 4 months; if they reported only one partner in the past 4 months, we coded that participant as being monogamous in the past 4 months. Within the dyad, if both of the partners reported only one sex partner in the past 4 months (i.e., reported only each other as sex partners), we coded the dyad as being mutually monogamous. If one participant (either index or partner) reported more than one sex partner in the past 4 months, we coded the dyad as having one non-monogamous member. If both index and partner participants reported more than one sex partner in the past 4 months, we code the dyad as having two non-monogamous partners. We coded dyad non-monogamy with dummy variables, with a variable for one partner being non-monogamous, and another variable for mutual non-monogamy.

## Statistical Analyses

We created three datasets for these analyses: one which contains only the index participants' reported sexual partnerships throughout the year (Specific Aim 1 analyses; N=536 participants); another containing records linking the index respondent to a partner participant (Specific Aim 2, inter-partner agreement analyses; N=151 dyads); and another containing index, partner and joint dyad responses (Aim 3 dyad agreement analyses; N=129 dyads). The first dataset was used to estimate the association between perceived partner non-monogamy and subsequent initiation of concurrent sexual partnerships (Specific Aim 1). The second and third datasets were used to assess agreement on dates of first and last sexual intercourse within dyads (Specific Aim 2).

### Specific Aim 1 Analysis

We hypothesized that the perception of a sex partner's involvement in other sexual relationships (perceived partner non-monogamy, or PPNM) may be a motivational factor in one's subsequent initiation of concurrent behavior (concurrency initiation, or incident concurrency). Using Poisson generalized estimating equations, we estimated the association between perceived partner non-monogamy and initiation of concurrency over the following 4-months producing three study intervals of interest: baseline to 4-months; 4- to 8-months; and 8- to 12-months.

Concurrency prevalence, with associated 95% confidence intervals, was estimated for the recall periods associated with baseline, 4-month, 8-month, and-12 month interviews. Concurrency incidence proportions were estimated for recall periods after the baseline interview. Participants who were coded as concurrent during a recall period were excluded from the concurrency incidence analyses for the immediately following recall period. Associations between concurrency and PPNM were estimated (across all recall periods) with Poisson regression using generalized estimating equations (GEE) with a robust variance estimator, to account for multiple observations per participant.

GEE models have been used widely in longitudinal studies, serial cross-sectional studies, and specifically in the modeling of sexual behavior initiation<sup>46</sup>. GEE has a number of advantages for modeling POPD data: first, GEE takes full advantage of longitudinal data and allows analysis of partnership initiation in reference to time; second, GEE provides a framework in which to account for dependent events (e.g. sexual behavior of the same respondent through time); and third, GEE can accommodate

correlated observations and repeated measurements from the same participants. Utilization of GEE with a Poisson distribution for our dichotomous outcome essentially acts as an extension of traditional Poisson regression, while accounting for repeated records per subject and correlation between events.

In our analysis, we are interested in estimating the risk of concurrency associated with perceiving, versus not having perceived, partners' non-monogamy. Because our outcome of concurrency was quite common in our sample, utilization of logistic regression to generate Odds Ratios would overestimate the Risk Ratio. While Poisson regression has a history of use in rare, counts-based data, literature supports its use in analyzing binary data,<sup>47-49</sup> even in datasets where outcomes may be common,<sup>48,49</sup> or where data are longitudinal,<sup>47,48</sup> or where data are correlated.<sup>48</sup> Though Poisson may typically overestimate error, literature has shown that a modified Poisson regression with a robust sandwich variance estimator (easily requested through SAS PROC GENMOD) can produce efficient and valid estimate of the Risk Ratio without issues of convergence in binomial regression. In our study, with repeated observations of up to four interview from over 536 participants, cluster size is large, and research demonstrates that when such conditions are present, Poisson regression with robust variance estimators can provide valid estimates of the Risk Ratio.<sup>48</sup>

We have thus chosen to utilize generalized estimating equations to estimate the association between perceived partner non-monogamy and concurrency, using a Poisson regression (e.g., log link and Poisson distribution), and specifying an unstructured working correlation and robust sandwich variance estimator. The unstructured working correlation poses no assumptions about correlation, and is efficient where the number of observations per cluster is less than 5.

A directed acyclic graph (DAG),<sup>50</sup> informed by a review of the literature, was used to identify potential confounders included in final models (the DAG is shown in Appendix 3.1). As previously defined in the Measures section, DAG-identified confounders consisted of: birth sex, race/ethnicity, age at sexual debut, lifetime number of sex partners at baseline, and alcohol or other drug use during sex for the recall period for which PPNM was reported. All statistical modeling for Aim 1 analyses was conducted in SAS 9.4 (SAS Institutes, Cary, NC). Data collection procedures were approved by the Oregon State University, Purdue University and California State University – Los Angeles Institutional Review Boards; the work

reported in this paper was approved by the University of North Carolina at Chapel Hill Institutional Review Board.

### Specific Aim 2 Analysis

For each of the 151 index-partner dyads, interviewed at 8- and 12-months, we assessed quality of reported dates with two comparisons: the first comparing individual index and partner participants' responses on dates of sexual intercourse to each other (Inter-Partner Agreement), and the second comparing index and partner participants' responses to the joint dyad report (Dyad Agreement).

#### *Inter-Partner Agreement*

We characterized agreement in dates of first and last sex between index and partner participants (Inter-Partner Agreement, IPA). To do this, we calculated the mean absolute difference, in days, between index and partner reports, and percent agreement to within 0-, 7-, 14-, 30-, 90-and, additionally for date of first sex, 365-days. We used linear regression to estimate associations between participant and partnership characteristics and the log of mean absolute differences between index and partner participants. We modeled the log, rather than the crude, mean absolute inter-partner in order to address the positive skew and outliers in inter-partner differences, and ensure variable normality (See Appendix 3.2 for more information on the distribution of inter-partner differences). Selection of regression covariates was informed by the literature, and were either known or hypothesized to be associated with agreement *a priori*: recall interval,<sup>22</sup> duration of partnership,<sup>22,44</sup> age difference between partners,<sup>44</sup> difference in reported frequency of sex between partners,<sup>38,51</sup> exclusivity,<sup>32,38,44</sup> STD history (hypothesized; coded as either index or partner participant), and alcohol or other drug use before or during sex with each other<sup>44,45</sup> (reported by either index or partner participant).<sup>45,46</sup>

#### *Dyad Agreement*

We examined characteristics of participants who had more agreement with joint dyad reports, by comparing dates of sex reported by index and partner participants, to those from joint dyad interviews. For each dyad, we identified which of the two participants had more agreement with joint dyad reports in terms of: age (older vs. younger participant); sex (male vs. female participant); role in study (index vs. partner participant); number of sex partners in lifetime (greater vs. fewer); relationship commitment (more

vs. less, as reported as a subset of the Investment Model Scale);<sup>41</sup> and power (more vs. less relationship power, as decided by the dyad in the joint dyad interview).

To estimate magnitude of agreement within each comparison, we estimated distance to joint dyad reports and distance differences for each comparison group. For date of first sex, we calculated distance in both mean and median. Although the mean provides a simple estimate of distance and allows for comparison with previous work, it is susceptible to outliers. Dates of first sex in our sample had notable outliers that skewed estimates; as such, medians are a more appropriate estimate.



## CHAPTER 4: PERCEIVED PARTNER NON-MONOGAMY AND SEXUAL CONCURRENCY

### **Abstract**

#### Objectives

We examined the association between perception of a partner's non-monogamy (PPNM) and simultaneous or subsequent concurrency among at-risk heterosexual young adults in Los Angeles.

#### Methods

We used Poisson regression models to estimate the relationship of PPNM with incident concurrency among 536 participants interviewed at four-month intervals during one year. Concurrency was defined as an overlap in reported sexual partnership dates; PPNM was defined as believing a partner was also having sex with someone else.

#### Results

Participants (51% female; 30% non-Hispanic White, 28% non-Hispanic Black, 27% Hispanic/Latino) had a mean age of 23 years and lifetime median of 9 sex partners. At each interview (baseline, 4-, 8-, and 12-months), concurrency prevalence was, respectively, 38.8%, 27.4%, 23.1%, and 24.5%. Four-month concurrency incidence at 4-, 8- and 12- months was 8.5%, 10.6%, 17.8%, respectively. Participants with recent PPNM were more likely to initiate concurrency (crude 4-month RR=4.6; 95%CI=3.0, 7.0; adjusted 4-month RR=4.0, 95%CI=2.6, 6.1).

#### Conclusions

Recent PPNM was associated with incident concurrency. Among young adults, onset of concurrency may be stimulated, relatively quickly, by the perception of a partner's non-monogamy.

## Introduction

Concurrent sexual partnerships have been suggested as a significant contributing factor in STI/HIV transmission and acquisition<sup>2,52-55</sup> by altering the structure of sexual risk networks and facilitating spread. Concurrency has been shown to be more common among young adults and racial/ethnic minorities, for a variety of social and behavioral reasons.<sup>11,12,17,53,56</sup> In a study examining concurrency patterns among adolescent STD clinic attendees aged 14-19 years, having concurrent sexual partnerships within the last 6 months was common (31%) and associated with having chlamydia and gonorrhea.<sup>56</sup> In a study of partnerships among a sample of young adults, Gorbach *et al.* found that 26% of partnerships had one or both partners involved in concurrent sexual relationships with others, and that those in partnerships in which one or both partners were non-monogamous were nearly 4 times as likely to report an STI diagnosis.<sup>17</sup> Using nationally representative data from the 2002 National Survey on Family Growth (NSFG), Adimora and colleagues estimated that about 11% of men<sup>11</sup> and about 6% of women<sup>57</sup> had a concurrent partnership in the previous 12 months. Concurrency was associated with racial/ethnic minority status, age under 30 years, early age at first intercourse, and substance use. Javanbakhht and colleagues found that concurrency was common among African American, Hispanic and Asian women, and associated with risk of Human Papillomavirus (HPV) infection.<sup>8</sup> Sexual partner concurrency may in part account for disproportionately high STI rates among young adults and racial/ethnic minorities. Understanding the factors associated with engaging in concurrent sexual behavior is an important step in reducing STI rates in these populations.

Cross-sectional survey data suggest a strong association between involvement in sexual concurrency and having a partner who is not monogamous. Gorbach and colleagues found that in 13% of partnerships both partners reported involvement in concurrent sexual behavior.<sup>17</sup> Adimora and colleagues found that men and women reporting a non-monogamous partner in the past year had odds of concurrency 13 and 23 the odds, respectively, of those who reported only monogamous partners.<sup>11,57</sup> Another cross-sectional study among young adults attending STI clinics found that 34% of participants engaged in reactive concurrency.<sup>58</sup> However, limitations in previous research have made it difficult to identify whether the association of concurrency with partner non-monogamy reflects a shared

understanding of non-exclusivity in the relationship or whether one partner's concurrency arises in response to the other's.

Specific motivations for concurrency are thought to be associated with varying degrees of STI/HIV risk.<sup>17,18</sup> In a qualitative study, Gorbach and colleagues (2002) identified six distinct concurrent partnership types in regard to underlying motivations: reciprocal, reactive, compensatory, transitional, separational, and experimental.<sup>17</sup> These different types are associated with different STI/HIV risk profiles, network configurations, and STI/HIV risk.<sup>17,18</sup> In our study, we seek to explore reactive concurrency, which, as described by Gorbach, is concurrency initiated following awareness of a partner's involvement in other relationships.<sup>17</sup> Reactive concurrent partnerships are possibly motivated by the desire to establish fairness in the relationship and jealousy; they are often deliberately casual in nature, and as a result, are associated with higher risk.<sup>17</sup>

Elucidating the social and behavioral motivations for initiating concurrency may provide valuable information for crafting STI/HIV prevention messages, particularly for high-risk groups. In this paper, we present longitudinal data on the potential contribution of perceived partner non-monogamy in motivating concurrency among a diverse sample of young adults.

## **Methods**

### Sample

We examined data from 536 individuals enrolled in the Project on Partner Dynamics (POPD), a cohort study of young adult heterosexual men and women in the Los Angeles area. POPD's primary objective is to examine the influence of heterosexual relationship dynamics on sexual risk perceptions, intentions, and behaviors. Between 2006 and 2008, participants were recruited directly from community locations, including STD clinics, family planning clinics and community organizations, and indirectly through print and online advertisements. Eligibility criteria included age (18-30 years), reporting unprotected sex in the previous three months, and having –or having a sex partner who had—one of the following risk factors: 1) more than one sex partner in the previous year; 2) history of STI treatment in the previous two years; 3) sex with a partner who had an STI in the previous year or who was HIV+; or 4) history of injection drug use.

Exclusion criteria included HIV infection (self-reported), current pregnancy, not speaking English or Spanish, or expecting to move outside the study area within a year. Eligible participants completed up to four interviews during one year, as they initiated, maintained and/or terminated sexual relationships.

Computer- and interviewer-assisted surveys were conducted in the participant's preferred language (English or Spanish) using Questionnaire Development System (QDS) software, with interviewers matched to participants based on birth sex and in most cases, race/ethnicity. Participants were asked their sexual partnerships during a recall period of the past four months (at baseline) or the time since the previous interview (referred to here as the "recall period"; the median time between interviews was 4 months). For each partner, identified by initials or nickname, the participant was asked about the following items during the recall period: date of first sex (vaginal or anal sex; only ascertained for a newly reported partner), date of last sex (vaginal or anal), frequency of sex (vaginal, anal), whether the participant thought that the partner had other partners during the relationship with the participant (i.e., perceived partner non-monogamy), and alcohol or other drug use before or during sex.

#### Missing Data, Exclusions, and Logic Checks

For each partnership, we identified missing, out-of-range and seemingly erroneous dates. In cases where the date of first or last sex was missing, or date of last sex came before date of first sex, we set first and last sex dates in that interval to be equal to each other unless the frequency of sex was 0, in which case we excluded the partnership. In cases where dates of first or last sex reported were later than the interview date: if the problem was an apparent error in reported year, we corrected the year; otherwise, we excluded partnerships if frequency of sex was 0, and, if the frequency of sex was greater than 0, set the date of last sex to the first date in the interview interval (i.e., the day after the previous interview). Additionally, we excluded 8 partnerships which were not ongoing at the baseline interview but were subsequently re-initiated during the course of the study, because of uncertainty about whether the partnership was active between the first and last intercourse dates available and the concern that including these partnerships might artificially inflate concurrency estimates.

### Definitions of Prevalent and Incident Concurrency

For each recall period, prevalent concurrency was defined dichotomously as having an overlap in time between two or more partnerships during the recall period, based on self-reported dates of first and last intercourse. Participants lost to follow-up or missing partnership data were excluded. Concurrency was classified as incident if the participant was not concurrent (i.e., no prevalent concurrency) during the previous recall period. Concurrency was coded using both a computer program and by manual review, to ensure classification accuracy.

### Definition of Perceived Partner Non-Monogamy

We hypothesized that perception of a partner's involvement in another sexual relationship (perceived partner non-monogamy, PPNM) may motivate the participant to initiate concurrency, such as in cases of reactive concurrency,<sup>17</sup> which we hypothesize occurs relatively quickly. For each ongoing partner during each recall period, PPNM was coded dichotomously using information from the question, "Which of the following best describes your relationship with [partner]". A response "I am certain [partner] has had sex with others while involved with me" or "I believe he/she probably has had sex with other people while involved with me" was coded as PPNM. Because of uncertainty about reporting accuracy, PPNM information was not collected for partnerships reported as terminated. Thus, at the participant-level, PPNM data was missing for participants who had no active partnerships at the time of the interview.

We coded PPNM as present or absent for each participant-recall period, rather than in relation to specific partners, because concurrency that arises in response to PPNM need not necessarily involve the partner who was believed to be non-monogamous. In our statistical analyses we examined the relationships of concurrency with PPNM from the same recall period ("recent PPNM"; 0-4 months ago) and with PPNM from the preceding recall period ("distant PPNM; 4-8 months ago).

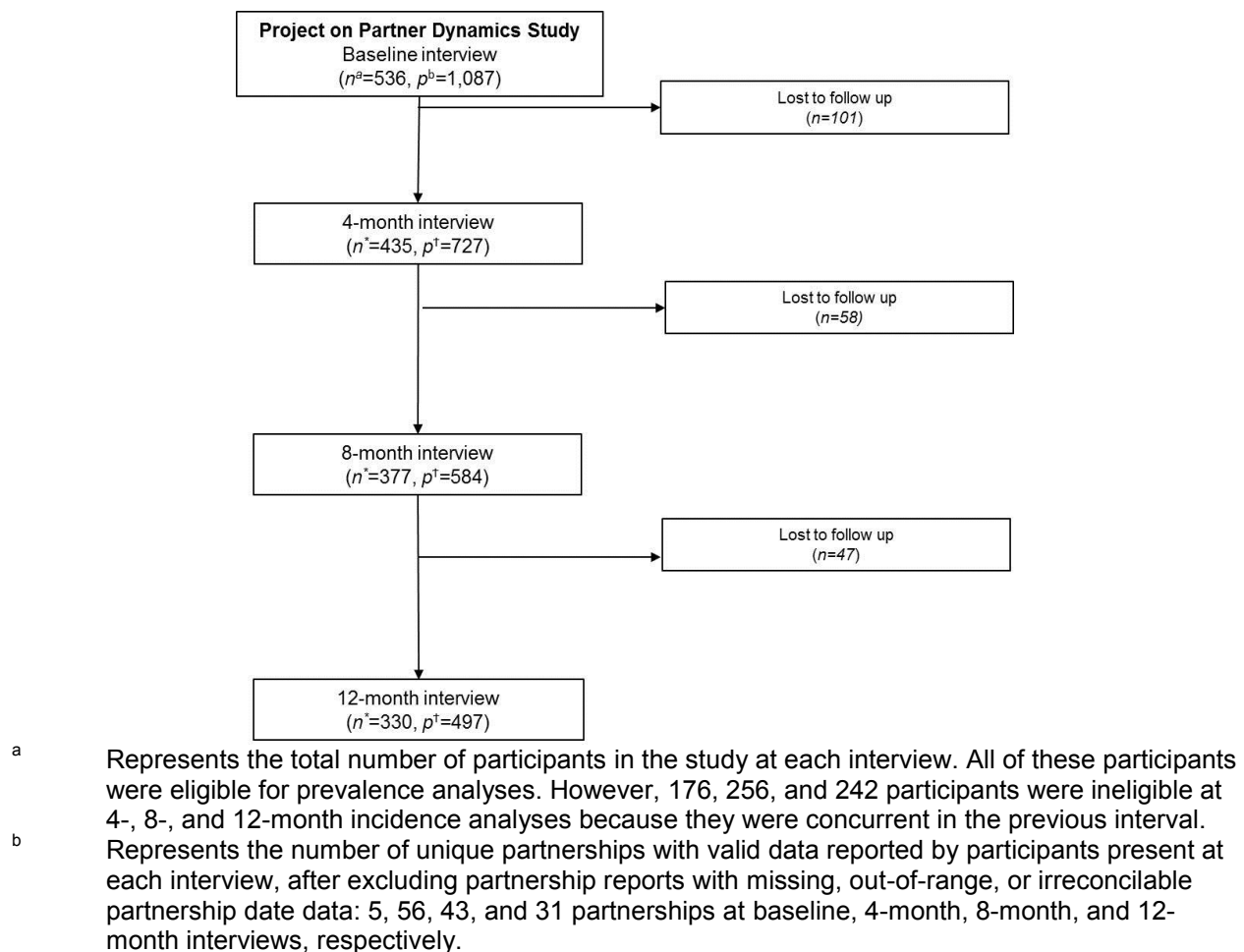
### Statistical Analyses

Concurrency prevalence, with associated 95% confidence intervals, was estimated for the recall periods associated with baseline, 4-month, 8-month, and-12 month interviews. Concurrency incidence proportions were estimated for recall periods after the baseline interview. Participants who were coded as concurrent during a recall period were excluded from the concurrency incidence analyses for the immediately following recall period. Associations between concurrency and PPNM were estimated (across all recall periods) with Poisson regression using generalized estimating equations (GEE) with a robust variance estimator, to account for multiple observations per participant. In longitudinal data, even when outcomes are common, several papers have demonstrated that modified Poisson regression with robust variance estimators can produce efficient and valid estimates of the risk ratio, in cases where the cluster size is large.<sup>47-49</sup>

A directed acyclic graph (DAG)<sup>50</sup>, informed by a review of the literature, was used to identify potential confounders included in final models. DAG-identified confounders consisted of: birth sex, race/ethnicity, age at sexual debut, lifetime number of sex partners at baseline, and alcohol or other drug use during sex for the recall period for which PPNM was reported. All statistical modeling was conducted in SAS 9.4 (SAS Institutes, Cary, NC).

The POPD study and this analysis were approved by IRBs from: Oregon State University, Purdue University, California State University Los Angeles, and UNC Chapel Hill.

**Figure 4.1: Project on Partner Dynamics Study Participants and Participant-Reported Partnerships Throughout One-Year of Follow Up**



## Results

### Demographic Characteristics

A total of 536 individuals participated in the baseline interview (Figure 4.1). Participation at follow-up was 435, 377 and 330, respectively, at the 4-, 8-, and 12-month interviews, for a total of 1,678 recall periods for analysis. Participants were balanced between males and females; about two-thirds were age 18-24 years old (Table 4.1). Participants reported a total of 1,792 unique sexual partnerships throughout the study. Of these, most were described as either “just friends” (34.2%), “dating casually” (24.3%), or “dating exclusively” (26.5%).

**Table 4.1: Selected Baseline Characteristics of Participants Enrolled in the Project on Partner Dynamics**

Characteristic	N <sup>a</sup>	%
Birth Sex		
Female	275	51.3
Male	261	48.7
Age (years) <sup>b</sup>	23 [3.8]	
18-24	336	62.7
25-30	200	37.3
Race/ethnicity		
White, non-Hispanic	159	29.7
Black, non-Hispanic	151	28.2
Hispanic/Latino	149	27.8
Other	77	14.4
Age at sexual debut (years) <sup>b</sup>	16 [2.6]	
≤15	192	35.9
16-18	269	50.3
>18	74	13.8
Number of sex partners, lifetime <sup>b</sup>	15 [18.9]	
1	19	3.6
2-5	138	25.8
6-10	146	27.3
11-49	196	36.7
>49	35	6.6
Number of sex partners, past 4 months <sup>b</sup>	2 [1.5]	
1	245	45.7
2	151	28.2
>2	140	26.1
Alcohol or other drug use during sex <sup>c</sup>		
Yes	399	74.6
No	136	25.4
History of STD diagnosis		
Yes	134	25.0
No	398	74.3
Don't know	4	0.8
History of injection drug use		
Yes	11	2.1
No	525	98.0
Sex with an injection drug user, ever		
Yes	53	9.9
No	453	84.5
Don't know	30	5.6

<sup>a</sup> Total number of non-missing observations. Missing observations: number of sex partners in lifetime (2); age at sexual debut (1); alcohol and other drug use in the past 4 months (1).

<sup>b</sup> Mean and [standard deviation]. Median and (Interquartile Ranges) for age, age at sexual debut, number of sex partners in lifetime, and number of sex partners in the past four months are as follows: 23 (6); 16 (3); 9 (13); 2 (2).

<sup>c</sup> Defined as reported alcohol and other drug use during sex with one or more partners in the past 4 months at the baseline interview.



### Prevalence and Incidence of Concurrency

Across the 1,678 4-month recall periods among participants, there were 498 periods with prevalent concurrency; in 92 of these periods, the participant had no concurrency in the preceding recall period, and was therefore classified as an incident case. A total of 271 participants (50.6%) were concurrent during one or more periods, including 117 (43.2%) females and 154 (56.8%) of males. Participants who were ever, versus never, concurrent in the study were, at baseline, more likely to be male (50.6% vs. 43.2%), and to report greater lifetime numbers of sex partners (19 vs. 11) and alcohol or other drug use during sex at baseline (82.3% vs. 66.7%).

**Table 4.2: Prevalence and Incidence of Concurrent Sexual Partnerships Among Those Enrolled in the Project on Partner Dynamics**

	Prevalent Concurrency <sup>a</sup>		Incident Concurrency <sup>b</sup>	
	N <sup>c</sup>	%	N <sup>c</sup>	%
Baseline	208/536	38.8	-	-
4-Months	119/435	27.4	22/259	8.5
8-Months	87/377	23.1	27/255	10.6
12-Months	84/330	24.5	43/242	17.8

<sup>a</sup> For each participant, prevalent concurrency at each interview was defined by an overlap in reported sexual partnership dates.

<sup>b</sup> Incident concurrency was defined as concurrency newly reported at an interview.

<sup>c</sup> Denominators for prevalence are all participants interviewed. Denominators for incidence are participants who were not concurrent during the previous recall period.

Prevalence and incidence of concurrency throughout the study are featured in Table 2. A substantial number of participants – 291 (54.3%), 175 (41.9%), 131 (36.2%) and 131 (34.0%), respectively, at baseline, 4-, 8-, and 12-month interviews – reported having had more than one sexual partner (irrespective of overlap) during the recall period. Most of these participants (71%, 68%, 66% and 79%, respectively) were specifically involved in concurrent partnerships, and substantial numbers of concurrent participants – 59 (28.4%), 53 (44.9%), 29 (33.3%) and 24 (28.6%) – had multiple ongoing partnerships at the time of each interview.

**Table 4.3: Unadjusted Associations of Selected Participant Characteristics with Prevalent and Incident Concurrency**

Characteristic	Prevalent Concurrency			Incident Concurrency		
	Prevalence <sup>a</sup>	PR	95% CI	Incidence <sup>a</sup>	RR	95% CI
Birth Sex						
Female	17.1%	Ref		9.5%	Ref	
Male	35.2%	2.1	1.6, 2.7**	16.5%	1.7	1.2, 2.6**
Age						
18-24	27.0%	Ref		14.2%	Ref	
25-30	23.2%	0.9	0.7, 1.1	9.2%	0.6	0.4, 1.0
Race/ethnicity						
White, non-Hispanic	24.6%	Ref		12.7%	Ref	
Black, non-Hispanic	25.2%	1.0	0.7, 1.5	11.1%	0.9	0.5, 1.5
Hispanic/Latino	28.1%	1.1	0.8, 1.6	15.7%	1.2	0.8, 2.0
Other	23.4%	1.0	0.6, 1.5	7.0%	0.6	0.3, 1.2
Age at sexual debut						
≤15	31.3%	1.4	1.1, 1.8 **	15.6%	1.5	1.0, 2.2
>15	22.4%	Ref		10.7%	Ref	
Number of sex partners, lifetime						
1-5	15.2%	Ref		8.0%	Ref	
6-10	20.1%	1.3	0.9, 2.0	12.6%	1.6	0.9, 2.7
>10	36.0%	2.4	1.6, 3.4**	14.8%	1.9	1.1, 3.0*
Alcohol or other drug use with 1+ partners, 0-4 months ago						
Yes	31.4%	2.0	1.5, 2.6**	16.3%	2.3	1.4, 3.6 **
No	15.9%	Ref		7.2%	Ref	
Alcohol or other drug use with 1+ partners, 4-8 months ago						
Yes	27.9%	1.5	1.1, 2.0 **	12.4%	1.2	0.8, 1.9
No	18.9%	Ref		10.5%	Ref	
Perceived partner non-monogamy, 0-4 months ago						
Yes	48.8%	2.7	2.1, 3.4 **	33.2%	4.6	3.0, 7.0 **
No	18.1%	Ref		7.2%	Ref	
Perceived partner non-monogamy, 4-8 months ago						
Yes	36.8%	1.9	1.5, 2.4**	15.3%	1.4	0.9, 2.3
No	19.5%	Ref		10.8%	Ref	

<sup>a</sup> Concurrency was defined as having overlapping partnerships during the 4-month recall period. Incident concurrency was defined as concurrency among participants who were not concurrent during the preceding recall period (i.e., 4-8 months ago).

\*  $P < 0.05$

\*\*  $P < 0.01$

#### Perceived Partner Non-Monogamy and Concurrency

At baseline, 4-, 8, and 12-month interviews, respectively, 46.3%, 22.0%, 22.0% and 19.2% of participants reported PPNM for at least one partner. A total of 0, 49, 44, and 41 participants, respectively,

had no ongoing partnerships and therefore did not have PPNM data. Participants with PPNM were more likely to themselves have overlapping partnerships during the same recall period (prevalence ratio [PR] = 2.7, 95% CI = 2.1, 3.4 unadjusted; PR = 2.5, 95% CI = 2.0, 3.1 adjusted). The corresponding concurrency incidence ratios were 4.6 (3.0, 7.0) unadjusted and 4.0 (2.6, 6.1) adjusted. Of the 92 recall periods with incident concurrency, 43 (46.7%) had either distant or recent PPNM. In adjusted models: male sex (PR=1.7; 95%CI=1.3, 2.2), Hispanic race/ethnicity (PR=1.6, 95%CI=1.2, 2.2), >10 lifetime sex partners at baseline (PR=1.6; 95%CI= 1.2, 2.4), and alcohol or other drug use with sex partners during the recall period (PR=1.8; 95%CI=1.4, 2.4) were associated with prevalence; male sex (RR=1.7; 95%CI=1.1, 2.6), Hispanic race/ethnicity (RR=1.8, 95%CI=1.1, 3.1), and alcohol and other drug use during the same recall period (RR=2.1, 95%CI=1.2, 3.5) were also associated with incident concurrency.

Participants with PPNM were also more likely to report concurrency during the subsequent recall period (PR=1.9; 95% CI = 1.5, 2.4 for concurrency prevalence; RR=1.4; 95% CI = 0.9, 2.3 for concurrency incidence; Table 4.3). The corresponding adjusted ratios were 1.6 (95% CI=1.3, 2.0) for concurrency prevalence and 1.2 (95% CI=0.6, 2.3) for concurrency incidence. In adjusted models: male sex (PR=1.8; 95%CI=1.4, 2.4), and >10 lifetime sex partners at baseline (PR=1.8; 95%CI=1.2, 2.7), were also associated with concurrency prevalence; male sex (RR=2.0; 95%CI=1.2, 3.4), was associated with concurrency incidence.

## **Discussion**

In this paper, we present concurrency estimates from a longitudinal study of ethnically diverse high risk heterosexual young adults. Our estimates are consistent with the proposition that perceived partner non-monogamy (PPNM) is an important motivational factor for concurrency in this sample. This association may include cases of reactive concurrency, thought to be a higher risk form of concurrency motivated by jealousy and/or the desire to establish equity.<sup>17</sup> The longitudinal design of the present study offered several advantages, including: relatively short recall periods, which likely improved recall accuracy; the opportunity to analyze concurrency incidence in participants who went from being non-concurrent to concurrent over the study period; and the ability to estimate associations between PPNM and concurrency during the same recall period and after a four-month lag.

Many participants engaged in concurrency during the course of the study. Our 4-month prevalence estimates, which ranged from 23% to 39% are similar to other studies examining concurrency frequency among young adults and adolescents.<sup>56,59</sup> Additionally, even when calculated over a relatively short period of time, 4-month occurrence of new concurrent behavior (incidence) was quite high in our sample, ranging from 9% - 18%. As concurrency has been shown to be independently associated with individual and population-level STI risk,<sup>10</sup> these estimates are consistent with the high-risk status of our study population.

Perceived partner non-monogamy was associated with both prevalent and incident concurrency. Those recently perceiving one or more partners to be non-monogamous were more than 4 times as likely as those who did not to initiate concurrency during the same 4-month interval. Cross-sectional associations between PPNM have been previously observed in both quantitative,<sup>57,58,60</sup> and qualitative studies.<sup>17,19</sup> However, cross-sectional studies cannot determine the temporal relationship between PPNM and concurrency, and a causal effect can easily be envisioned to occur in either direction. By looking specifically at incident concurrency, we have been able to investigate evidence that PPNM preceded concurrency much of the time. By comparing the specific dates of partnerships for participants with recent PPNM and incident concurrency, we found that for 22 subjects (67%), concurrency possibly or likely began after the partnership with PPNM, consistent with our interpretation that PPNM may have motivated at least some of the concurrency observed (see Appendix 4.1 for more information). Further, since the association was much stronger for incident concurrency with PPNM during the same recall period than with PPNM during the preceding recall period, an effect of PPNM on incident concurrency may operate in a short time frame.

Since data were not obtained about the specific reasons for initiating a concurrent partnership, whether PPNM itself was the motivation cannot be inferred with certainty from these data. For example, rather than reflect reactive concurrency, the perception of a partner's non-monogamy may reflect a mutual non-monogamy agreement (reciprocal concurrency).<sup>17</sup> To further explore the relationship between perceived partner non-monogamy and concurrency, future research should address partnership-specific motivations for initiating relationships, and examine this association in other populations.

As many as 12% of participants did not have PPNM data at an interview because all of their partnerships during the recall period had terminated. We explored the potential impact of the missing PPNM data by conducting a sensitivity analysis that treated coded participants with no PPNM data for this reason as positive for PPNM and then as negative for PPNM. Because participants having only terminated partnerships were not likely to have concurrent partnerships, both sensitivity analysis scenarios yielded results similar to the original estimates. By contrast, participants with one or more ongoing partnerships and one or more partnerships that had terminated were likely to have had concurrent partnerships. PPNM data were not obtained for any terminated partnerships, but since PPNM was a composite measure across all partnerships for each participant, this lack of PPNM information could only understate a participant's PPNM.

As other studies of concurrent sexual partnerships, ours relies on retrospectively recalled dates of first and last sex. Such reporting is subject to memory failure, imprecision and recall bias.<sup>9,22-25,61</sup> However, because of the relatively short recall period, we expect these problems to be less serious than in studies asking participants to report partnerships over the past year or even longer. Another variable where self-report may not map directly to behavior is PPNM, where incongruities between perception of partner behavior with partners' reported behavior have been well-documented.<sup>43,44,59,60,62,63</sup> Data from dyadic studies suggest that the positive predictive value of PPNM is 46% to 69%, i.e., among those who perceive a partner to be non-monogamous, the perception is congruent with the partners' reported behavior 46%<sup>43</sup> to 69%<sup>59</sup> of the time. The negative predictive value ranges from 73% to 82%, i.e., among those who perceive their partners to be monogamous, the perception is congruent 73%<sup>43</sup> to 82%<sup>59</sup> of the time (see Appendix 4.2. 4.3 and 4.4 for information on these estimates). However, even an incongruent perception that one's partner is non-monogamous has been found to be associated with concurrency<sup>59,60,64</sup> and STI risk,<sup>60</sup> as perceptions drive behavior. Because young adults who perceive partner non-monogamy may be more likely to initiate risky sexual behavior, a client's perception of partner non-monogamy may be a clinically useful indicator of STI/HIV risk.

Nevertheless, greater accuracy of monogamy perceptions may lead to behavior that, in turn, reduces STI risk. Correctly perceiving that a partner is monogamous may avoid the impulse for reactive concurrency. Correctly perceiving that a partner is non-monogamous may motivate termination of the

partnership, greater use of condoms, or mutual non-monogamy with greater attention to safer sexual practices. Among young adults, a population for which explicit monogamy or non-monogamy expectations may be rare,<sup>65</sup> interventions which build relationship skills may improve communication and increase accuracy of perceived partner behavior.

## **Conclusions**

Overall, these data suggest that perceived partner non-monogamy motivates young adults to initiate concurrency, within a relatively narrow time window. Our findings highlight the importance of young adults as an at-risk population, the importance of perceived partner non-monogamy as a risk factor for sexual risk, and the possible benefit for reducing STI risk through relationship-level interventions dealing with partnership communication surrounding monogamy expectations.

## **Acknowledgements**

This work was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number F31HD068126 to Diana M. Sanchez (PI), Award Number R01HD47151 to S. Marie Harvey (PI), and Award Number 1K24HD059358-01 to Adaora Adimora (PI). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

## CHAPTER 5: INTER-PARTNER AND DYAD AGREEMENT ON SEXUAL PARTNERHSIP DATES

### **Abstract**

#### Background

Sexual partnership dates are frequently collected for STI/HIV research and control programs, though validity is limited by memory failure and imprecision.

#### Methods

We examined data from 302 heterosexual young adults (151 index-partner dyads). Dates of first and last sexual intercourse were collected through individual interviews and a joint dyad interview. We compared index- and partner-reported dates to estimate inter-partner agreement (IPA). We used log-linear regression to model associations between differences in reported dates and partnership characteristics. To assess validity, we compared individually-reported dates to those from joint dyad interviews.

#### Results

Most partnerships were <2 years in duration (66.2%) and many (36.2%) were non-monogamous. IPA to within 1-, 30-, and 365-days was, respectively, 5.6%, 43.1% and 81.3% for first sex; and 32.9%, 94.5%, and 100.0% for last sex. In adjusted models: longer relationship duration was associated with disagreement on first sex dates; partnership non-monogamy was associated with lower agreement on dates of first sex and last sex. Within dyads, the dyad interview report more closely matched the report from participants who were female (54.7% agreement vs. 45.3% for first sex; 62.5% agreement vs. 37.5% for last sex), had fewer sex partners (58.5% vs. 41.5% for first sex; 53.8% vs. 46.3% for last sex), or had greater relationship commitment (56.3% vs. 43.7% for first sex; 52.2% vs. 47.8% for last sex).

## Conclusions

Agreement was high on date of last sex but only moderate on date of first sex. Methods to increase quality may improve STI research.

## **Introduction**

Dates of sexual activity are regularly collected in STI research as well as in STI/HIV control activities such as contact tracing. However, dates obtained from recall are subject to methodological challenges such as memory failure, imprecision, and reporting bias.<sup>9,23-25,27,29,30,51,61</sup> Inaccuracy and imprecision have implications for STI research, such as studies estimating partnership duration and concurrency,<sup>18,21</sup> and for STI control programs that ascertain potentially exposed partners in a given time period. Assessing the quality of reported dates of sexual intercourse is important for establishing a margin of error for estimates, identifying factors associated with greater reporting error, and suggesting targets for efforts to improve accuracy. Although various studies have assessed the quality of sexual partnership data<sup>32,38,39,44,45,51,66-71</sup>—examining number of sex partners,<sup>68,69</sup> whether sex acts occurred,<sup>44,45,66,70,72</sup> age of first intercourse,<sup>67,69</sup> and frequency of sex<sup>39,45,69,71-73</sup> and condom use—<sup>51,71,73</sup> research on the quality of sexual partnership dates<sup>22,71,74,75</sup> is limited.

Comparing dates of sexual activity as reported by individuals in a dyad provides an opportunity to assess agreement which, in the absence of a “gold standard,” may be a surrogate for validity. In a study of dyads in Thailand,<sup>71</sup> De Boer and colleagues estimated that 3-day agreement on estimated time since last sex was 63.2% for HIV sero-concordant and 65.0% for sero-discordant dyads. Brewer and colleagues found moderate agreement on date of first sexual intercourse among 774 sexual dyads: 56% agreed on the exact date, an additional 32% agreed to the month, and an additional 12% to the year.<sup>22</sup> That study also found that dyads identified through HIV partner tracing provided less reliable reports. In a sensitivity analysis based on simulations, the authors found that the observed level of misclassification did not yield meaningfully different categorization of concurrent sexual partnerships. In sum, available literature suggests that inter-partner agreement is moderate but that those most at risk for STI/HIV may provide systematically less reliable sexual partnership information.

An additional opportunity to estimate quality arises from comparing information reported by individuals within a dyad with that obtained from joint dyad interviews, in which both partners are



interviewed together. Joint dyad interviewing may allow partners to remind each other about relevant information (“collaborative recall”) and to corroborate one another’s recall.<sup>33-35,37,76</sup> Therefore joint dyad interviews may provide more nearly valid information than that obtained from one of the individuals in the dyad.<sup>34</sup> A potential liability of joint dyad interviews, however, is the possibility that responses may be influenced by dyadic power dynamics.<sup>77</sup> This possibility is of particular concern for value-laden measures such as condom use, relationship status or satisfaction. Dyadic power dynamics may be of less concern for dates of sexual activity, however. Though joint dyad interviews have been used to qualitatively explore reasons for disagreement in partner reports of dates of sex,<sup>66</sup> no studies have utilized joint dyad interviews to assess agreement on dates of sexual partnerships.

In this paper, we present agreement estimates on dates of first and last sexual intercourse based on comparisons 1) between the members of a dyad interviewed separately and 2) between each member of the dyad and their joint dyad interview.

## **Methods**

### Study Population and Data Collection

We analyzed data from dyads enrolled in the Project on Partner Dynamics (POPD),<sup>40,78</sup> a longitudinal study of young adult heterosexual men and women in the Los Angeles area. Between 2006-2008, POPD recruited (index) participants directly from community locations, including STD clinics, family planning clinics and community organizations, and indirectly through print and online advertisements. Eligible index participants were between 18-30 years of age, reported unprotected sex in the previous three months, and had –or had a sex partner who had– at least one additional risk factor. Exclusion criteria included self-reported HIV infection, speaking neither English nor Spanish, current pregnancy, or anticipating moving outside the study area within a year.

Eligible, consenting index participants completed interviewer-administered, computer-based interviews in their preferred language (English or Spanish) every four months for one year. At 8- and 12-month interviews, index participants were invited to bring one current sex partner for an interview. Both the index participant and his/her partner (i.e., partner participant) were interviewed separately and,

afterwards, were invited to participate in a joint dyad interview, where index and partner participants completed a self-administered paper questionnaire together.

The separate interviews asked participants about all sexual partnerships active during the preceding four months (i.e., since the previous interview, for index participants) and, for each partnership, dates of first and last sex (vaginal or anal) with the questions: "What was the date of the first [last] time you had sex with [PARTNER]?". For index participants, date of first sex was asked only during the first interview where the partnership was named. Date of last sex was collected at each follow-up interview, for as long as the relationship continued. Separate interviews also included questions on participant's age, race/ethnicity, age at first sexual intercourse, number of sex partners in lifetime and in the past 4 months, history of STD and injection drug use, and for each sexual partner during the preceding four months: nature of relationship, sexual exclusivity, coital frequency, degree of relationship commitment, relationship power, and alcohol or other drug use before or during sex. Relationship commitment was measured with an 7-question subset of the Investment Model Scale;<sup>41</sup> the dyad member with the higher commitment score in separate interviews was coded as having "greater commitment" in dyad agreement analyses.

In the joint dyad interview, participants were instructed to agree upon the day, month, and year, and provide a consensus answer to the question, "What is the date of the first [last] time you had sex with one another?". Dyadic power was collected during joint dyad interviews with the question "*Thinking about one another, who do you think has more power in the relationship?*". We coded the responses "*She does*" and "*both partners but more her*" as indicating that the female participant had more power in the dyad, and the responses "*Both of us, but more him*", or "*He does*" as indicating that the male participant had more power.

The POPD study was approved by Institutional Review Boards from: Oregon State University, Purdue University, and California State University Los Angeles. The present analysis was approved by the UNC Chapel Hill Institutional Review Board.

### Exclusions, Missing Data, and Logic Checks

In order to make our assessment of agreement most relevant for interpreting data analyzed in a typical study, where data would be cleaned but where comparisons to partner and dyad reports would not be available, we attempted to impute or correct missing, out-of-range, and apparently erroneous dates using only information within the same interview. For example, if a reported date was later than the date of the interview, as confirmed by administrative records, we considered the possibility of a mistake in the reported year (e.g., forgetting to increment calendar year in January). If there were no obvious errors in reported year, we excluded the date from further analysis. If a date of last sex was earlier than a date of first sex, we corrected obvious errors in the year or, failing that, excluded both dates from further analysis. These procedures results in 10 intercourse dates being corrected (approximately 1% of all dates).

### Inter-Partner Agreement

For dates of first and last sex, we quantified agreement between index and partner reports (Inter-Partner Agreement, IPA) by taking the absolute differences, in days, and summarizing the distributions with means, medians, upper quartiles (75%) and percent agreement (exact and within 7, 14, 30, 90, and 365 days).

We used linear regression to estimate associations of participant and partnership characteristics with the log of the mean absolute differences between index and partner participants. Exponentiated model coefficients therefore estimate the ratio of geometric means between covariate groups. We used the log transformation in order to remove the positive skew in the distribution of raw differences and to reduce the impact of outliers.

Selection of regression covariates was informed by the literature, and were either known or hypothesized to be associated with agreement *a priori*: recall interval<sup>22</sup>, duration of partnership<sup>22,44</sup>, age difference between partners<sup>44</sup>, difference in reported frequency of sex between partners<sup>38,51</sup>, exclusivity<sup>32,38,44</sup>, STD history (hypothesized; coded as either index or partner participant), and alcohol or other drug use before or during sex with each other<sup>44,45</sup> (reported by either index or partner participant). Because index participants could have reported dates of first sex during an earlier interview than when

partner participants were recruited, we included time between index and partner's interviews (the recall interval) in models of first sex agreement.

#### Individual-Dyad Agreement

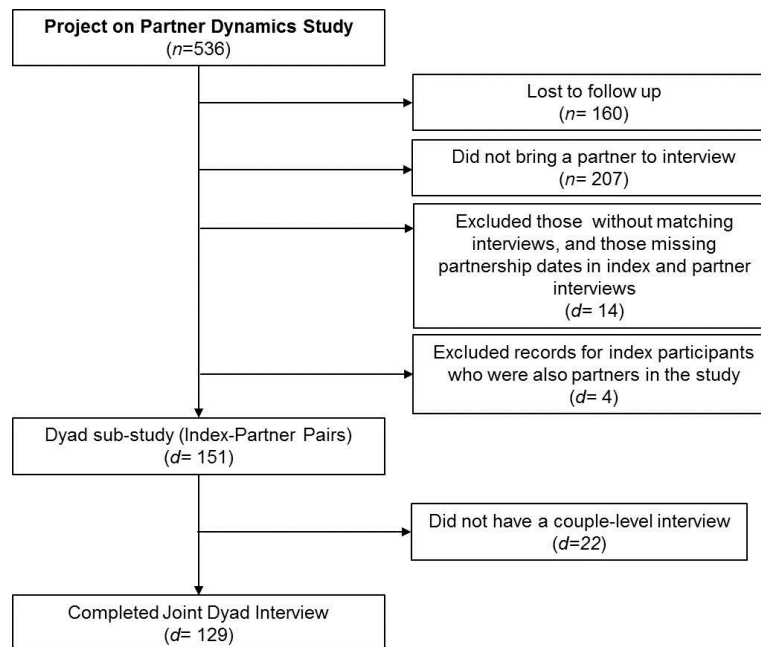
For each dyad, we identified which participant's individual reports agreed more closely with the joint dyad reports, in relation to which of the two participants was older, was female, was an index participant (rather than partner participant), had a greater lifetime number of sex partners, had greater relationship commitment, and had greater relationship power (as reported in the joint dyad interview). Additionally, to estimate magnitude of disagreement within each comparison, we estimated mean absolute differences, in days, between the date reported in the dyad interview and the date reported by dyad participants with that characteristic (e.g., female partners, older partners, etc.). We estimated means as a simple summary of distances and to facilitate comparison with previous studies. Particularly for dates of first sex, however, means were strongly influenced by outliers. We therefore summarized difference distributions with medians providing a bound for a greater majority of observations and a more robust summary of the extent of large disagreement.

All analyses were conducted using SAS 9.4 (SAS Institute; Cary, NC).

## **Results**

A total of 169 index POPD participants recruited a partner for the dyad sub-study (i.e., 169 dyads). After exclusion of 14 dyads lacking information needed to link records or to make at least one date agreement comparison, and of 4 dyads in which index participants were also interviewed as partners of another index participant (Figure 5.1), 151 dyads (302 unique participants), were included in this analysis.

**Figure 5. 1: Participants and Dyads Enrolled in the Project on Partner Dynamics, 2006-2009.**



*n* = individual participants originally enrolled in POPD study (i.e., index participants)  
*d* = dyads (i.e., index-partner pairs)

Index participants in the dyad sub-study were similar to all POPD participants at baseline in terms of gender, age, race/ethnicity, history of STD, number of sex partners in lifetime, and age of sexual debut. Index participants in the present analysis were somewhat more likely to be Hispanic/Latino (33.8% vs. 27.8%), and less likely to report use of alcohol/other drugs during sex in the past 4 months (74.6% for all POPD participants at baseline, 63.4% for index participants in the present analysis). Also, whereas POPD index participants classified 36.4% of their baseline partnerships (60.7% of their partnerships at 8-months) as “Dating exclusively”, “Engaged”, or “Married”, index participants in the dyad sub-study classified 80.4% of their partnerships in these categories. Index participant’s ratings of commitment were also higher for partnerships represented in the dyad sub-study (mean 5.9) than for all reported partnerships eligible for recruitment (mean 4.6).

**Table 5. 1: Select Characteristics of Index and Partner Participants Enrolled in the Project on Partner Dynamics Sub-study, 2006-2009.**

Characteristic	Index Participants (N=151)		Partner Participants (N=151)	
	N <sup>a</sup>	%	N <sup>a</sup>	%
Sex - Female	73	48.3	78	51.7
Race/ethnicity				
White, non-Hispanic	38	25.2	48	34.0
Black, non-Hispanic	37	24.5	32	22.7
Hispanic/Latino	51	33.8	36	25.5
Other	25	16.6	25	17.7
Age <sup>b</sup>	23.1 ± 3.7		24.8 ± 6.1	
Number of sex partners, lifetime <sup>b</sup>	16 ± 21.6		12 ± 15.1	
Number of sex partners, past 4 months <sup>b</sup>	1 ± 1.3		1 ± 1.1	
Age at sexual debut <sup>b</sup>	16 ± 2.9		16 ± 2.6	
History of STD	44	29.1	34	22.7
History of injection drug use	7	4.6	3	2.0
Alcohol/ other drugs during sex, past 4 months	78	63.4	88	62.4
Reported description of partnership status				
Just friends	12	8.1	11	7.48
Dating casually	11	7.4	17	11.56
Dating exclusively	78	52.3	86	58.50
Engaged	21	14.1	17	11.56
Married	21	14.1	13	8.84
Other	6	4.0	3	2.04
Commitment Scale <sup>b, c</sup>	5.9 ± 1.9		6.2 ± 1.9	
Perception of partner with more power				
Partner Participant	4	3.2	7	5.0%
Both, but more the partner participant	32	25.6	50	36.0%
Both, but more index participant	75	60.0	67	48.2%
Index Participant	14	11.2	15	10.8%
Not Applicable/Missing	26		12	

- a Total number of non-missing observations. race/ethnicity (10 missing for partner participant); History of STD (1 missing for index, 1 missing for partner participants), History of Injection Drug Use (1 missing for partner participant), alcohol or other drug use (28 missing for index; 10 missing for partner participants), description of partnership status (2 missing for index; 2 for partners)
- b Mean ± Standard Deviation.
- c Score based off of a 7-question subset of the Investment Model Scale, with higher responses (8 on a given question) representing more commitment, and lower scores (0 on a given question) representing lower commitment.

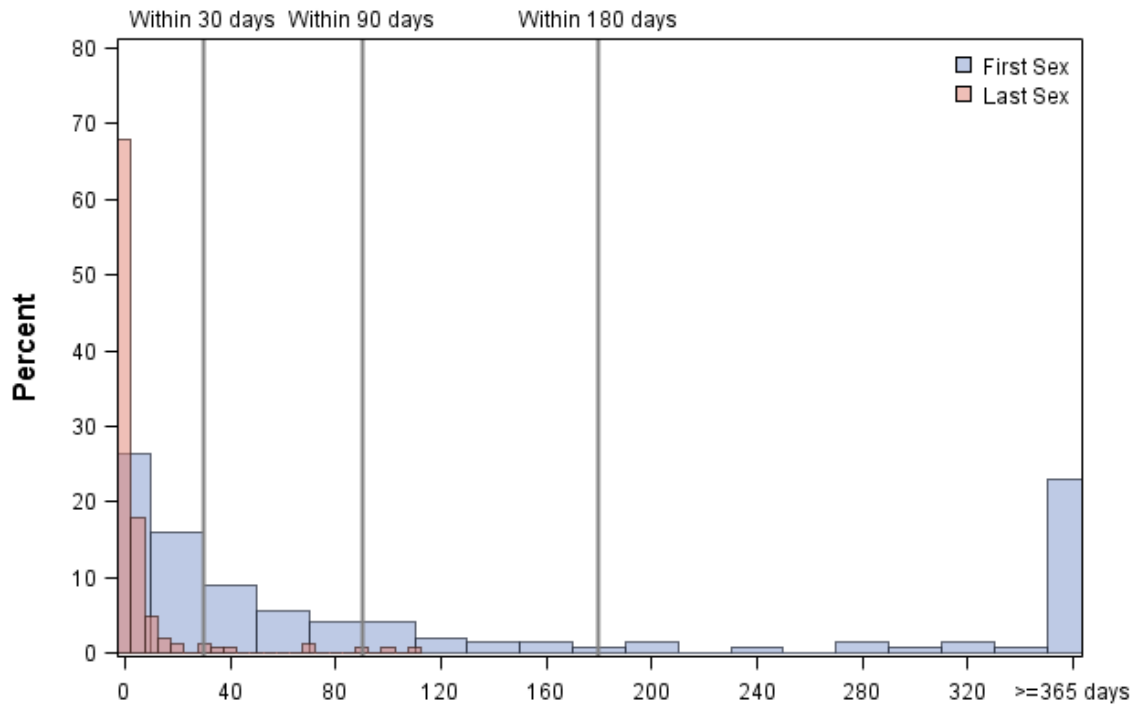
Index and partner participants, respectively, had an average age of 23 and 25 years, and an average number of 16 and 12 lifetime sex partners (Table 5.1). At the dyad-level, partnerships had an average duration of 2 years and in over one-third (36.2%) of dyads, at least one participant was non-monogamous in the past 4 months (Table 5.2).

**Table 5.2: Select Characteristics of Dyads (n=151) Enrolled in the Project on Partner Dynamics**

Characteristic	N	%
Duration of sexual partnership, years <sup>a</sup>	1.9 ± 1.9	
<1 Year	57	38.5
1-2 Years	41	27.7
2-4 Years	33	22.3
4-10 Years	17	11.5
Missing	3	
Interval between interviews for ascertainment of first sex date <sup>b</sup>		
0 Months (i.e., date asked at same visit from both partners)	24	16.2
4 Months	12	8.1
8 Months	102	68.9
12 Months	10	6.8
Missing	3	
Monogamy, past 4 months		
Mutually report being monogamous	95	63.8
One partner report being non-monogamous	28	18.8
Both partners report being non-monogamous	26	17.5
Missing	2	
Age difference between partners, years <sup>c</sup>	4 ± 4.2	
Mean absolute difference in reported sex frequency, past 4 months <sup>c</sup>	26 ± 45.1	
Joint dyad response: which partner has greater relationship power <sup>d</sup>		
More the female partner	8	6.7
Both partners, but more the female partner	47	39.2
Both partners, but more the male partner	57	47.5
More the male partner	8	6.7
Missing/Not Present at Couple Interview	31	

- a Duration of partnership was calculated as the difference between year of last sex and year of first sex, as reported by the index participant.
- b Recall interval between partners was calculated as the amount of time between partners recalling date of first sex. Date of last sex was always collected on the same interview date. Missing values for recall interval occurred when dates of first sex were missing for the partnership.
- c Mean ± Standard Deviation. Medians age difference was 2 years, and the median difference in reported sex frequency was 12.
- d Responses captured in a joint interview with both members of the dyad. Responses reflect those in response to the question “*Thinking about one another, who do you think has more power in the relationship?*”

**Figure 5.2: Histogram of Absolute Differences, in Days, Between Index- and Partner-reported Dates of First and Last Sexual Intercourse**



#### Date of First Sex: Inter-Partner Agreement

We found low-to-moderate agreement on date of first sex (Table 5.3). The distribution of absolute inter-partner differences had a mean of 265 days and median of 47 days. In 27 dyads, index and partner participants disagreed by more than 365 days (Figure 5.2); excluding these outliers reduced inter-partner differences to 71 days (mean) and 25 days (median). The upper quartile of the difference distribution was 309 days before exclusion of outliers and 86 days afterwards. The majority of participants (62.5%) agreed on date of first sex to within 90 days, though less than half (43.1%) agreed to within 30 days, and few (6%) on exact date.



**Table 5. 3: Inter-partner Agreement on Dates of First and Last Sexual Intercourse**

	<b>Inter-partner Agreement<sup>a</sup></b>			
	<b>First sexual intercourse (N=144)</b>		<b>Last sexual intercourse (N =146)</b>	
	<b>N</b>	<b>%</b>	<b>N</b>	<b>%</b>
Same date	8	5.6	48	32.9
Within 7 days	34	23.6	125	85.6
Within 14 days	47	32.6	133	91.1
Within 30 days	62	43.1	138	94.5
To calendar month	57	39.6	130	89.0
Within 90 days	90	62.5	144	98.6
Within 180 days	101	70.1	146	100.0
Within 365 days	117	81.3	146	100.0

a Inter-partner agreement compares reported dates of first and last sexual intercourse provided by the index and partner participants in individual interviews.

Longer partnership duration (ratio of geometric means: 1.5 (95% confidence interval (CI)= 1.3, 1.8)) and greater recall interval (2.3 (95% CI=1.1, 4.9)) was associated with greater disagreement in in unadjusted analyses. In adjusted analyses, longer partnership duration (1.5 (95% CI=1.3, 1.8)) and partnership non-monogamy (2.5 (95% CI=1.1, 6.1)) were associated with disagreement (Table 5.4).

**Table 5. 4: Crude and Adjusted Associations Between Partnership Characteristics and Log of Mean Inter-partner Differences**

	N <sup>a</sup>	Inter-Partner Agreement, First Sexual Intercourse				Inter-Partner Agreement, Last Sexual Intercourse			
		Mean days <sup>b</sup>	Geom. mean days <sup>b</sup>	Geometric mean ratio, crude (95% CI)	Geometric mean ratio, adjusted (95% CI)	Mean days <sup>b</sup>	Geom. mean days <sup>b</sup>	Geometric mean ratio, crude (95% CI)	Geometric mean ratio, adjusted (95% CI)
<i>Model intercept</i>					2.15				
Recall interval <sup>c</sup>									
0-4 Months	36	279	26	Ref	Ref				
8-12 Months	112	261	58	2.3 (1.1 ,4.9)*	0.6 (0.6 ,3.3)				
Partnership duration (β,1-year)				1.5 (1.1 ,1.8)***	1.5 (1.3 ,1.8)***			1.0 (0.9 ,1.1)	1.0 (0.9 ,1.1)
Age difference (β,1-year)				1.0 (1.0 ,1.1)	1.0 (1.0 ,1.1)			1.0 (1.0 ,1.0)	1.0 (1.0 ,1.0)
Difference in reported sex frequency <sup>d</sup> (β, 1-act)				1.0 (1.0 ,1.0)	1.0 (1.0 ,1.0)			1.0 (1.0 ,1.0)	1.0 (1.0 ,1.0)
Monogamy <sup>d</sup>									
Both monogamous	95	242	46	Ref	Ref	4	2	Ref	Ref
One non-monogamous	28	286	59	1.3 (0.5 ,3.1)	2.5 (1.1 ,6.1)*	7	3	1.3 (0.8 ,2)	1.2 (0.8 ,1.9)
Both non-monogamous	26	322	36	0.8 (0.3 ,1.9)	1.2 (0.5 ,3.0)	15	6	2.7 (1.7 ,4.3)***	2.8 (1.7 ,4.5)***
STD ever, index or partner									
No	88	226	38	Ref	Ref	5	3	Ref	Ref
Yes	63	315	63	1.7 (0.9 ,3.3)	1.2 (0.7 ,2.4)	8	3	1.2 (0.8 ,1.8)	1.2 (0.9 ,1.8)
AOD use before or during sex <sup>d</sup>									
No	47	386	64	Ref	Ref	9	4	Ref	Ref
Yes	103	212	41	0.6 (0.3 ,1.3)	0.9 (0.5 ,1.8)	5	3	0.7 (0.5 ,1.1)	0.9 (0.6 ,1.3)

\*  $P < 0.05$  \*\*  $P < 0.01$  \*\*\*  $P < 0.001$ 

a Corresponds to dyads with complete, non-missing data for covariates and dates of first [last] sexual intercourse.

b Arithmetic and geometric mean number of days between index and partner's reports on date of intercourse. Geometric means were estimated using regression models.

c Recall interval represents the time between index and partner participants being asked about date of first sex.

d Covariate measurement correspond to the past 4-month recall period, at the time of the interview

#### Date of First Sex: Individual-Dyad Agreement

The distribution of absolute differences between date of first sex reported in the joint dyad interview and that reported by the index participant had a mean of 149 days and median of 22 days, with 75% of index participants reporting a date within 101 days of the joint dyad report (i.e., upper quartile of 101 days). Differences between the joint dyad interview and by partner participants were for the most part considerably smaller: mean 154 days, median 2 days, and upper quartile of 73 days.

Older participants, female participants, those with fewer sex partners, those with greater relationship commitment, and those with less relationship power provided dates closer to those from the joint dyad interview (Table 5.5). Mean differences were greatest in comparing partner vs. index participants (-57 day difference; 95%CI= -101, -13); the greatest difference in upper quartiles was seen for younger vs. older participants (21-day difference; 95%CI=3, 40).

#### Date of Last Sex: Inter-Partner and Individual-Dyad Agreement

Agreement was higher for last sex than for first sex (Table 5.3). Mean and median absolute inter-partner differences for date of last sex were 6 days and 1 day, respectively, with an upper quartile of 4 days. In unadjusted and adjusted analyses, dyads in which both participants reported non-monogamy (unadjusted ratio of geometric means: 2.7 (95%CI=1.7, 4.3); adjusted: 2.8 (95%CI=1.7, 4.5)) were less likely to agree on date of last sex (Table 5.4).

Both index and partner participants reported dates of last sex date close to the joint dyad report (mean absolute difference 3 days for index, 5 days for partner). Index participants and those who were younger, were female, had fewer sex partners, and had greater relationship commitment and power were in closer agreement with the joint dyad report, though only for number of partners was the confidence interval on one side of the null (Table 5.5). The difference in means between groups was highest in comparing those with fewer vs. more sex partners (-5.3 day difference; 95%CI=-10.5, -0.4; Table 5.5).

**Table 5.5: Characteristics of Participants Agreeing with Dates of First and Last Sexual Intercourse Obtained in Joint Dyad Interview**

Characteristic of Participant Closer to Joint Dyad Report	Date of First Sexual Intercourse (N=129)						Date of Last Sexual Intercourse (N=129)			
	N	(%) <sup>a</sup>	Mean <sup>b</sup>	Difference in Means (95%CI)	Median	Median Difference (95% CI)	N	(%)	Mean <sup>b</sup>	Mean Difference (95%CI)
<b>Age</b>										
Older participant	48	51.1	35	Ref	0	Ref	30	47.6	1	Ref
Younger participant	46	48.9	38	3.4 (-40.2, 47.0)	3	1 (0, 5)	33	52.4	6	-4.7 (-10.4, 1.0)
Not Applicable <sup>c</sup>	7/16/0						41/13/3			
<b>Sex</b>										
Male participant	53	45.3	35	Ref	2	Ref	30	37.5	4	Ref
Female participant	64	54.7	28	-7.1 (-42.0, 27.9)	0	-1 (-3, 0)	50	62.5	2	-1.7 (-7.1, 3.6)
Not Applicable <sup>c</sup>	7/0/0						44/0/0			
<b>Role in Study</b>										
Index participant	44	37.6	67	Ref	12	Ref	43	53.8	3	Ref
Partner participant	73	62.4	10	-57.0 (-101.0, -12.9)	0	-10 (-19, -3)	37	46.3	3	0.7 (-4.2, 5.6)
Not Applicable <sup>c</sup>	7/0/0						44/0/0			
<b>Number of sex partners<sup>d</sup></b>										
More sex partners	44	41.5	46	Ref	3	Ref	33	45.2	6	Ref
Fewer sex partners	62	58.5	23	-23.2 (-62.7, 20.4)	0	-1 (-5, 0)	40	54.8	1	-5.3 (-10.5, -0.4)
Not Applicable <sup>c</sup>	7/10/0						41/6/3			
<b>Commitment<sup>e</sup></b>										
Greater commitment	59	57.3	21	Ref	1	Ref	37	52.9	3	Ref
Less commitment	44	43.7	50	29.6 (-10.1, 69.2)	1	0 (-1,1)	33	47.1	4	1.6 (-4.0, 7.1)
Not Applicable <sup>c</sup>	7/11/0						41/8/0			
<b>Power in relationship<sup>f</sup></b>										
More power	53	48.6	46	Ref	2	Ref	40	53.3	2	Ref
Less power	56	51.4	17	-29.0 (-66.1, 8.0)	0	0 (-2, 0)	35	46.7	5	3.8 (-1.7, 9.3)
Not Applicable <sup>c</sup>	7/0/0						41/13/0			

a May not sum to 100% due to missing data.

b Average (arithmetic mean) number of days between participants in each category and joint dyad report of first/last sex.

c Not applicable responses due to: equally close dates / same value for the variable / equally close dates and the same value.

d Number of sex partners in lifetime, ascertained at baseline for index and at partner interview for partners.

e Score based on 7-question subset of the Investment Model Scale; higher score coded as having "greater commitment".

f Measured using question: "thinking about one another, who would you say has more power in your relationship?".

## Discussion

We examined agreement on sexual intercourse dates obtained from three sources – index participants, partners recruited by index participants, and a joint dyad interview – to assess the accuracy of reported dates of sexual intercourse. Overall, we found substantial agreement on dates of last sex, and low-to-moderate agreement on dates of first sex. Due to processes of collaborative recall, cross-cueing, memory jogging and corroboration,<sup>33,35</sup> the joint dyad report is likely to be the most accurate of these sources. We therefore used the joint dyad report to validate individual's reports.

Our observation of excellent agreement between partners on date of last sexual intercourse, with the majority of participants agreeing to within a week, is similar to a previous assessment of estimates of time since last intercourse.<sup>71</sup> Agreement on date of last sex was likely affected by study design, which required index participants to recruit a partner from an ongoing sexual relationship within the preceding 4 months. Thus, date of last sex occurred necessarily within the past 4 months. However, even with high agreement overall, dyads in which both partners were non-monogamous provided systematically less consistent reports for date of last sex, similar to a previous study on test-retest agreement.<sup>31</sup> Overall, however, the better agreement on dates of last sex is reassuring for STI/HIV control activities, such as partner notification and contact tracing, since these rely on dates of last sex rather than of first sex. We found only modest agreement on date of first sex, with less than half of participants agreeing to within 30 days. These estimates are appreciably lower than a previous assessment of agreement.<sup>22</sup> Inconsistencies between index and partner reports may be due to a variety of factors. First, in the POPD study, index and partner participants often had dates of first sex collected at the different times, with the majority of index participants (68.9%) asked about date of first sex 8-months before partner participants. However, even for the 24 dyads who reported date of first sex at the same visit, responses differed by a mean of 324 days and median of 22 days. Second, although participants were informed that sex was defined as anal or vaginal intercourse at the beginning of the interview, it is possible that at the point where intercourse dates were asked, participants may have used different definitions, which has been found to contribute to discrepancies in previous studies.<sup>24,66</sup> Third, in this population of young adults, many relationships were terminated and re-initiated. In these cases, some participants may have interpreted date of first sex as the date of first sex ever with the partner, while others might interpret the

question as first sex date for the most recent re-initiation of the partnership. Finally, we found that those in relationships of longer duration and relationships involving non-monogamy provided less consistent dates. These findings could reflect the greater cognitive demands posed by asking participants to remember events occurring further in the past and differentiate events between multiple partners.

For dates of first sex, the index and partners' reports were over 365 days apart for 27 dyads (18% of all dyads). In most of these dyads, index and partner participants reported dates that had the same calendar month (9 dyads) or were within 30 days of each other (15 dyads), except for having a different calendar year. Either of these patterns could arise if the calendar year was misremembered or mis-keyed. The fact that so many dyads reported a different year for date of first sex emphasizes the importance of using strategies to assist with memory and retrieval of dates. Using these techniques may be particularly important in research utilizing both first and last sex dates—such as studies of duration, gap length, and concurrency<sup>21</sup>—, in which incorrect dates can result in misclassification. Various methods of enhancing participant memory have been proposed, including incorporating reminders of variable definitions, double-entry of responses, computer-generated validation checks, and use of life calendars<sup>30</sup>. Technology-based interventions – for example, having participants reference their own social media or mobile application accounts as personal life calendars – may also show promise in enhancing recall.

Agreement among comparable sources is sometimes used as a surrogate for validity, particularly in situations where no “gold standard” (diaries, for example) is available. However, agreement between sources may mean that both are inaccurate, and, conversely, low agreement does not preclude the possibility that one source is highly accurate. Although validity studies are needed to truly evaluate the quality of reported dates of sex, a gold standard with which to measure validity of dates is infrequently collected, in part due to the logistical complexities of doing so. Additionally, although inter-partner analyses may help in identifying partnership-level characteristics associated with better or worse agreement, individual characteristics related to more accurate reporting cannot be identified. This distinction is important, as individual markers of quality could provide guidance for strategies to improve reported sexual partnership data.

Using joint dyad interviews as a “gold standard”, we found that for both first sex and last sex, dates reported in the joint dyad interview more closely matched the individual reports of participants who

were female, had fewer lifetime sex partners, or had greater relationship commitment. We did not observe a tendency for the more powerful member of the dyad to provide the report closer to the joint dyad report for first sex. Therefore, collaborative inhibition, where one partner is the unofficial “spokesperson” of the relationship,<sup>33</sup> does not appear to have been an important factor. In terms of the magnitude of difference—using quartiles to diminish the impact of outliers— the strongest associations with better agreement were observed in relation to age and partnership commitment (for date of first sex) and with lifetime number of sex partners (for date of last sex). More accurate reporting of dates of sex is expected for people with fewer sex partners, since cognitive demands are fewer, and previous research suggests that reporting of high frequency events tends to be less accurate and consistent.<sup>38,51</sup> Similarly, since personal salience and vividness of an event increase the likelihood that it will be remembered,<sup>27</sup> it is expected that partners with greater commitment within a dyad should be more likely to recall aspects of that relationship. These individual-level factors may provide potential insights for crafting interventions to improve recall. However, use of joint dyad interviews for sexual health measures is novel, and more research is needed to understand the ability of joint dyad-level data to act as a “gold standard” comparison measure.

## **Conclusions**

We found high agreement on date of last sex, and only low-to-moderate agreement on date of first sex. Interventions to improve accuracy of reported sexual partnership data could benefit research.

## **Acknowledgements**

This work was supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health under Award Number F31HD068126 to Diana M. Sanchez (PI), Award Number R01HD47151 to S. Marie Harvey (PI), and Award Number 1K24HD059358-01 to Adaora Adimora (PI). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

## **CHAPTER 6: DISCUSSION**

Though a substantial body of literature supports the association between concurrent sexual behavior and risk of STI, particularly among racial/ethnic minorities and young adults, associations between factors with concurrency are difficult to interpret without the assurance that the other factor predated concurrency, and little is known regarding the quality of concurrent sexual partnership dates. Factors implicated in concurrency initiation, as well as the quality of sexual partnership dates, have important implications for research in sexual partnerships. In these analyses, we examined two factors related to sexual partnerships: the motivational impact of perceived partner non-monogamy (PPNM) on initiating an overlap in sexual partnerships, or concurrency; and the quality of reported sexual partnership dates.

### **Specific Aims and Key Findings**

#### Specific Aim 1:

Estimate the association between the belief that one's partner has another sexual partner (perceived partner non-monogamy) and initiation of concurrent partnerships over 4 months.

#### Hypotheses:

Perceived partner non-monogamy will significantly predict the index partner's initiation of a concurrent partnership during the following 4 months.



### Key Findings

- Perceived partner non-monogamy was associated with both prevalent and incident concurrency.
- In both prevalence and incidence analyses, recently perceiving partner non-monogamy had a stronger effect than distantly perceiving partner non-monogamy.
- Those who recently perceived partner non-monogamy were more than four times as likely as those who did not to have initiated concurrency within four months.

### Specific Aim 2 :

Evaluate agreement between sexual partners' reports of the dates of their first and last sexual intercourse.

### Hypotheses:

In inter-partner analyses, partnerships with larger age differences and/or substance abuse will tend to have lower accuracy for reporting dates. In dyad agreement analyses, dates provided in joint dyad interviews will tend to match the original report of index or partner participants, rather than represent an intermediate value between index- and partner-reported dates.

### Key Findings

- We found high agreement to dates of last sex, and low-to-moderate agreement on dates of first sex.
- Longer duration of partnership and non-monogamy within the dyad were associated with disagreement between index and partner participants on dates of sex.
- Joint dyad reports, which are likely to be the most nearly valid of all the sources of data, were most similar to reports from female participants, participants with fewer sex partners, and participants with greater relationship commitment.

## **Strengths and Limitations**

### Specific Aim 1

Most concurrency research to date has been based on cross-sectional data. As a result, temporality cannot be established, and little is known regarding factors associated with concurrency initiation. In the Aim 1 analysis, we estimated concurrency incidence from a longitudinal dataset, and examined the role of perceived partner non-monogamy (PPNM) as a motivational factor involved in initiating concurrent sexual partnerships. By looking specifically at incident concurrency, we have been able to investigate evidence that PPNM preceded concurrency much of the time. Examining partnership information for participants with sufficient information on recent PPNM and incident concurrency, we found that for 22 subjects (67%), concurrency possibly (39%) or likely (27%) began after the partnership with PPNM, suggesting that many cases may be consistent with our interpretation that PPNM may have motivated concurrency (see Appendix 4.1 for full results).

However, data were not obtained about the specific reasons for initiating a concurrent partnership. As a result, whether PPNM itself was the motivation cannot be inferred with certainty from these data. It is possible, for example, that rather than reflect reactive concurrency, the perception of a partner's non-monogamy may reflect a mutual non-monogamy agreement (reciprocal concurrency)<sup>17</sup>.

The POPD study only assessed perception of partner non-monogamy for ongoing, active partnerships at each interview, and as many as 12% of participants did not have PPNM data at an interview because all of their partnerships during the recall period had terminated. We explored the potential impact of the missing PPNM data by conducting a sensitivity analysis that treated participants with no PPNM data for this reason as positive for PPNM (Scenario 1) and then as negative for PPNM (Scenario 2). Because participants who had only terminated partnerships were not likely to have concurrent partnerships, both sensitivity analysis scenarios yielded results similar to each other. By contrast, participants with one or more ongoing partnerships but at least one terminated partnership were more likely to have had concurrent partnerships. PPNM data were not obtained for any terminated partnerships, but since PPNM was a composite measure across all partnerships for each participant, this lack of PPNM information could only understate a participant's PPNM.

## Specific Aim 2

In Aim 2 analyses, we estimated agreement between partners in a dyad, and compared responses of individual participants within a dyad to a joint dyad measure.

Agreement among comparable sources is sometimes used as a surrogate for validity. However, agreement between sources may occur even when both are inaccurate and, conversely, low agreement does not preclude the possibility that one source is highly accurate. Although validity studies are needed to truly evaluate the quality of reported dates of sex, a gold standard with which to measure validity of dates is infrequently collected, in part due to the logistical complexities of doing so. Inter-partner analyses may help in identifying partnership-level characteristics associated with better or worse agreement. However, individual characteristics related to more accurate reporting cannot be identified. This distinction is important, as individual markers of quality could provide guidance for strategies to improve reported sexual partnership data. Under the assumption that joint dyad reports may be more nearly valid due to collaborative remembering and corroboration<sup>33-35,37</sup>, comparing individual responses to a joint dyad response offers a unique opportunity to examine validity, a major strength of these analyses.

Index participants invited only one sex partner into the dyad sub-study at the time of partner recruitment, which limits the ability to generalize results to all sexual partnerships. Recruited partnerships were necessarily ongoing at months 8 and 12, and there may be some bias associated with assessing agreement among steady or active partnerships versus terminated partnerships. We did not find any notable demographic differences in partner participants recruited into the sub-study compared with all partners reported at 8-month interviews. However, as we expected, we found that – compared to all partnerships reported by index participants at 8-month interviews, the time of partner recruitment – partner participants enrolled in the study were more likely to be serious or exclusive relationships, and have higher commitment levels: 80.4% of the partnerships in the dyad sub-study (versus 60.7% of all partnerships at 8-months) were characterized by index participants as “Married”, “Dating exclusively” or “Engaged”; additionally, commitment ratings for sub-study partnerships were higher than for all reported partnerships at 8-months (commitment scores of 5.9 for recruited partner participants vs. 4.6 for all index-reported partnerships eligible for recruitment at 8-months). As exclusivity and commitment are likely to

increase inter-partner agreement, it is possible that our findings on agreement may be biased so that they overestimate agreement.

### **Validity of Reported Sexual Partnership Data**

In our analysis of perceived partner non-monogamy and incident concurrency, those who recently perceived a partner to be non-monogamous were more than 4 times as likely to have initiated concurrency in the past 4 months. However, although these perceptions may be motivators to initiate concurrent sexual partnerships, previous research suggests that perceived partner non-monogamy may inaccurately reflect partner's reported behavior<sup>43,44,59,60,62,63</sup>. Previous dyadic studies estimate that the positive predictive value of PPNM is 46% to 69%, i.e., among those who perceive a partner to be non-monogamous, the perception is congruent with the partners' reported behavior 46%<sup>43</sup> to 69%<sup>59</sup> of the time. The negative predictive value ranges from 73% to 82%, i.e., among those who perceive their partners to be monogamous, the perception is congruent 73%<sup>43</sup> to 82%<sup>59</sup> of the time (see Appendix 4.4 and 4.5 for full comparison of sensitivity, specificity, positive and negative predictive values for perceived partner non-monogamy in the literature). Using data from the POPD dyad sub-study, we compared partner participant's perception from the past 4 months to index participant's behavior for the same period. We found values similar to other studies: sensitivity ranging from 23-28%, specificity from 84-89%, positive predictive value from 14-41%, and negative predictive value from 81-92% (see Appendix 6.1-6.3 for more information on the calculation of each of these values). The low sensitivity of PPNM suggests that roughly one-quarter of participants in the POPD sub-study were unaware of their partner's concurrent sexual behavior. Additionally, of those perceiving partner non-monogamy, not many – between 14-41% – had perceptions that matched partner's reported behavior. Together, these findings suggest that perceptions of partner behavior may be powerful motivators, irrespective of whether or not they reliably match partner's reported behavior. The low accuracy of these perceptions also provides an opportunity for interventions to reduce sexual risk-taking. It is possible that relationship-level interventions which seek to increase communication skills between partners may be effective in, among other aspects, increasing partners' awareness of monogamy expectations and the ability to make decisions based on partner's behaviors.

In Aim 2 analyses, we examined validity of reported sexual partnership data, by estimating inter-partner and dyad agreement on reports of sexual partnership dates. We found high agreement on date of last sex, and low-to-moderate agreement on date of first sex. The high agreement on date of last sex suggests that STD control programs using these dates – such as contact tracing and partner notification programs – may be relatively unaffected by inaccurate date reporting. However, agreement on first sex was much lower than expected – and indeed, lower than previous estimates of first sex agreement<sup>22</sup>— which may be due to a number of cognitive factors and logistical concerns unique to the POPD study: 1) the time lag between index and partner participants being asked to report date of first sex; 2) index and partner participants possibly using different definitions of sex when recalling dates; 3) for partnerships that were terminated and re-initiated, possible confusion about reporting date of first sex ever, versus date of first sex in the current re-initiation of the relationship; and 4) as relationships involving non-monogamy and of longer duration had less reliable reports, the cognitive demands of remembering partner-specific events among multiple partnerships, as well as the demands of remembering events further in the past.

### **Quality of Reported Dates and Concurrency Misclassification**

Our estimates of inter-partner agreement suggest that although programs which utilize only dates of last sex (e.g., contact tracing) may be relatively unaffected by inaccuracy of reported dates, research which uses both first and last dates of sex – such as studies of duration, gap length and concurrency – may be more vulnerable to reporting errors. It is possible that the lack of agreement we found in our Aim 2 analyses could have had an impact on the classification of concurrency in our Aim 1 analyses, though the magnitude of concurrency misclassification would depend on a number of factors, including whether imprecision was differential by partnership, as well as duration of overlap.

In theory, concurrency misclassification due to imprecision could arise if a participant had differing degrees and directions of imprecision for reported partnerships. Even in cases of great discrepancy between index and partner-reported dates, if a single participant recalled all partnerships with the same level and direction of imprecision (i.e., all reported dates of partnerships were approximately 30 days after the “true” date), then the relative timing of partnerships would be intact, as would concurrency classification. If, however, imprecision varied considerably by partnership, then concurrency could be susceptible to misclassification. However, in a simulation study, Morris and O’Gorman found only a

modest difference (a true value of 33.3%, and simulated prevalence of 35.9%; an absolute change in prevalence of about 3 percentage points) in the estimated prevalence of concurrency before and after introducing a random error estimate for all reported partnerships<sup>74</sup>. The authors concluded that measurement error in surveys likely produces only a slight positive bias in estimating concurrent sexual partnerships (i.e., increasing the rate of concurrency “false positives”)<sup>74</sup>. Additionally, the authors found that the largest proportion of misidentified cases occurred for partnerships furthest in the past. Because our concurrency analyses estimated concurrency within a relatively small and recent window (i.e., the past 4 months), we might expect that concurrency misclassification in our concurrency analyses would be much less probable than for studies estimating concurrency for a larger time window (e.g., concurrency in the past year, concurrency in the past 5 years).

Duration of overlap also has implications for the robustness of concurrency classification. As agreement to 30-days was moderate, we might expect that overlap in partnerships to the calendar month would be relatively robust to imprecision. In this case, concurrency to the month rather than to the day would only be discrepant in cases where date of first sex for one partner was the same month as that for date of last sex for another partner (in which case, we might assume serial monogamy to be conservative about concurrency estimates). A separate POPD analysis<sup>40</sup> led by researchers at Oregon State University estimated duration of concurrency overlap. For males and females, respectively, concurrency overlap was estimated to be: between 92 and 170 days for transitional concurrency; between 34 and 68 days for contained concurrency; and between 19 and 28 days for multiple partner concurrency<sup>40</sup>. It is possible that measurement error could affect the calculation of overlap duration. However, in a simulation analysis by Morris and O’Gorman, the authors found that measurement error likely introduces a slight negative bias in overlap, such that duration of overlap is likely under-estimated compared to “true” values<sup>74</sup>. In our analysis, concurrency motivated out of perceived partner non-monogamy would likely be most similar to a transitional (e.g., participant experiences an overlap in partnerships while they transition from one partner to another) or contained concurrency (e.g., participant remains in one partnership, starts a new partnership, and continues both) pattern. For these types of concurrencies, longer duration of overlap—well over one month, in most cases – suggest that dichotomously classifying participants as concurrent or not may be robust against the level of imprecision we observed in POPD.

## Directions for Future Research and Practice

Results from these analyses raise a number of questions to be addressed by further research, and provide evidence for recommendations in the field of sexual health and STD epidemiology.

In Aim 1 analyses, we estimated the association between perceived partner non-monogamy and incident concurrency. Although we were able to examine the possibility of temporality in this relationship – finding that in many cases, PPNM indeed preceded concurrency initiation – future research is needed to further tease apart the specific motivational impact of perceived partner non-monogamy on initiating concurrency. Further, previous literature, as well as a supplemental analysis from the POPD sub-study, finds that perception of a partner's non-monogamy often differs from partner's reported behavior<sup>43,44,59,60,62,63</sup>. More research is needed to explore the potential utility of skills-building interventions focused on communication, which may decrease concurrency through increased partner communication of monogamy expectations.

We found low-to-moderate agreement between index and partner participants on date of first sex. Additionally, a considerable proportion of dyads (18%) disagreed on date of first sex by more than 365 days; of these, over half (55%) were less than 30 days apart except for having a different calendar year, which suggests the possibility of misremembering or mis-keying responses. As recall of specific sexual partnership dates poses considerable cognitive demands on participants, memory assistance aids and data validation strategies play a critical role in ensuring quality data collection.

More research is needed to understand the mechanisms of recall error in regards to sexual partnership dates, and the effect to which different characteristics (gap length vs. duration vs. concurrency) are potentially affected by imprecision. For example, in order to better understand the extent to which concurrency definitions are affected by imprecision in dates, a future study could ascertain concurrency with different definitions – indirect, classified by overlap in reported sexual partnership dates, or directly asking participants if partnerships overlapped in time – and then use qualitative interviews to reconcile differences in concurrency classification, should they exist.

If we interpret the joint dyad report to be a “gold standard”, our results from dyad agreement analyses provide insights into which members of heterosexual dyads may provide more reliable reports on dates of sex: females, those with fewer sex partners in lifetime, and those with greater commitment.

These individual-level factors may assist in crafting interventions to improve recall. However, use of joint dyad interviews for sexual health measures is novel, and more research is needed to understand the validate use of joint dyad-level data to act as a “gold standard” comparison measure.

#### Summary of Recommendations for Research and Practice

Based on our results, we propose the following suggestions:

1. Where possible and relevant, future concurrency analyses should include perceived partner non-monogamy as a covariate.
2. Memory assistance devices should be routinely incorporated into research contexts, particularly if date of first sex is measured.
3. More research is needed on innovative “gold standards” for reported sexual partnership dates, which can assist in assessing the impact of date imprecision in the classification of time-specific measures, such as concurrency, duration and gap length.

#### **Conclusions**

In these analyses, we explored two aspects of sexual partnerships relevant to STI epidemiology:

1) motivations for initiating an overlap in sexual partnerships, or concurrency; and 2) the extent to which partners in a dyad agree on reported dates of sexual partnership, which are routinely collected in STD research and control efforts. We found that PPNM and concurrency were associated, and at least in many cases, PPNM preceded initiation of concurrency. Reporting of dates of last sexual intercourse appears to be accurate, though reporting of first sexual intercourse had considerably inaccuracy. Innovative methods for measuring sexual partnership dates could assist in future studies of agreement as well as misclassification.



## APPENDIX 1.1: COVARIATES, EXPOSURES AND OUTCOMES OF INTEREST

Characteristic	Associated with Perceived partner non-monogamy (Citations)	Associated with Reported Concurrency (Citations)	Associated with Interpartner Agreement or Test- Retest Reliability (Citations)
<i>Individual-level factors</i>			
Gender	3,42	3,19,42,43	69
Age	Hypothesized	3,42	
Sexual Debut	Hypothesized	3,42	
Race/ethnicity	19	3,13,15,42	
Drug use, ever	Hypothesized	3,42	
STI diagnosis	60	8,16	
Relationship commitment	Hypothesized	Hypothesized	
<i>Partnership-level factors</i>			
Duration of partnership	-	-	22,44
Interview Interval	-	-	22
Age	-	-	44
Drug or alcohol use in partnership	-	-	44,45
Agreement on frequency of sex	-	-	38,51
Number of sex partners, past year	-	-	Hypothesized
Marital status*	-	-	32,38,44

\*Unmeasured in POPD study.

## APPENDIX 1.2: LITERATURE REVIEW ON REPORTED SEXUAL PARTNERSHIP DATES

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Brener (2003) <sup>27</sup>	Review	-	-	-	-	Threats to validity: 1) Cognitive barriers (comprehension; retrieval; decision-making, and response generation); 2) Situational factors (privacy, confidentiality, social desirability, trust). Cognitive barriers for sexual health information specifically involve terminology used in question, length of the recall period, vividness of the event, frequency of the event. More frequent behavior tends to be reported less accurately than less frequent, because people remember more frequent events less specifically. Situational factors in sexual health data include privacy, embarrassment, stigma, fear of disapproval.
Dare (1994) <sup>28</sup>	Review	-	-	-	-	Present issues with data collection of sexual partnership data, its potential challenges, and attempts to assess quality. 1) Convergent validity used to describe level of agreement between partners or methods of collection; 2) External validity are comparing to some independent source of information.
Fenton (2001) <sup>25</sup>	Review	-	-	-	-	Threats to sexual behavior data and methodological challenges: reporting and recall bias, participation bias, questionnaire design and content.

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Weinhart (1998) <sup>30</sup>	Review	-	-	-	-	Provides suggestions for quality improvement in sexual behavior data: using validated measures;; clear language; establish trust; include improvement techniques (provide anchor dates, encouraging use of appointment books and calendars, remind participants to consider times of extensive abstinence or consistent sex); place burden of denial on participants.
Valentine (1999) <sup>33</sup>	Review	-	-	-	-	Review of using household interviews vs. individual interviews in family studies, and specifically interviewing couples in heterosexual partnerships. Interviewing multiple household members can add depth (and complexity) to resulting data; allow for relationship dynamics to be explored; pose certain methodological problems for interviewer. Interesting points: 1) Household members/couples have shared reality that are negotiated jointly; 2)households may have unofficial “spokesperson” for outside world. Interviewing together involves negotiation and mediation, where couples corroborate each other’s’ stories, directly (engaging in discussion) or indirectly (not objecting to answer), jog memories, challenge recounts, expand on their version of event, providing validated accounts.

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Gribble (1999) <sup>24</sup>	Review	-	-	-	-	Compare modes of collecting sexual behavior data, such as self-administered vs. in-person interviews; telephone interviews; ACASI vs. CASI; In general, more likely to get behavioral data reports from in-person interviews.
Catania (1990) <sup>23</sup>	Review	-	-	-	-	Review measurement of error in sexual partnership data: 1) over and under-reporting (bragging, misestimating, etc.); 2) refusal rates; 3) test-retest reliability. Also reviews sources of error: 1) Memory – vividness, complexity and personal salience; 2) behavioral complexity; 3) pattern complexity (e.g., routine patterns vs. non-routine patterns); 4) emotional issues (pleasurable and negative emotions can enhance salience of the event); 5) self-presentation bias (wishing to present oneself in a positive light); 6) motivation and motivational bias (performing the role of the respondent).
Shroder (2003) <sup>26</sup>	Review	-	-	-	-	Review of the methodological challenges in sexual risk behavior data: 1) cognitive demands (task and memory error; length of window; level of measurement (dichotomous vs. frequency), frequency of target behavior, literacy skills, 2) social contexts (motivational bias, question format, question administration), and provide suggestions, including use of diaries as a gold standard, and evaluating the effects of outliers.

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Beitin (2008) <sup>34</sup>	Review					Examining 84 qualitative research papers in family therapy: Over half of interviews used individual interviews, separate from family members or partners. Joint interviewing provides an opportunity to obtain information not possible in individual interviews – such as relationship dynamics, and collaborative recall. However, selection of joint vs. individual interviewing should be made on the basis of research questions and objectives, and consider the safety of the respondent (and to the relationship) in providing answers jointly versus individually.
Graham (2003) <sup>51</sup>	Research	75 heterosexual students	Validity (compared self-report to diary)	Whether or not sex acts occurred, and frequency of events	Diary vs. In-person interviews 1, 2, or 3 months later	Assessed the effect of lag time on accuracy of results, by comparing self-report at 1, 2, and 3 months to diary methods (participants were randomized to a one of the three follow-up times). Lag between interviews was found to significantly affect recall, as was alcohol and the higher frequency of the event.
McAuliffe (2007) <sup>39</sup>	Research	493 adults	Validity (self-report in interviews vs. diary)	Frequencies of sex and condom use	Diary vs. Subsequent Questionnaire	Significantly underreported rather than over-reported measures in surveys, compared to diaries. Great consistency when asking participants by each partner, and CASI methods. Overall, quite high error rates, however.

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Brewer (2006) <sup>22</sup>	Research	774 Dyads in STD Contract Tracing Studies	Precision (Agreement) and Mean Differences in Dates of Sex	First sex, last sex	Interviewer-assisted interviews of index and partners	Many agreed to the exact date of sexual exposure, and overall agreement was reasonably good and not associated with socio-demographic characteristics.
Capaldi (1996) <sup>67</sup>	Research	200 Adolescent boys Grades 8-11	Test-Retest Reliability of First Intercourse	Whether or not they had sex; Age at first sex	Interviewer-assisted independent interviews, repeated 1 year intervals  (Interviewers reminded them of school year dates)	Overall, boys had a high likelihood of reporting that sex did occur (yes/no), but not reliability of when. Of boys interviewed twice about age at first sex, only 34.5% provided the same age; for boys interviewed three times, only 18% provided the same response each time; of those interviewed four times, only 3% provided the same response each of the times. Behavioral factors were not found to predict test-retest reliability.
Nyitray (2009) <sup>68</sup>	Research	1,069 men in Brazil, Mexico and US	Test-Retest Reliability	Various: lifetime sex partners, frequency of sex and condom use, STD diagnosis, etc.	Computer-assisted self-interview, repeated 3 weeks apart	Test-retest reliability was high for measures assessed – which largely were whether or not things had happened, and frequency of risk behaviors, though not the relative dates of occurrence.

Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
De Boer (1998) <sup>71</sup>	Research	529 couples	Reliability	Sexual frequency, condom use, time since last intercourse, contraceptive use	Interviewer-assisted independent interview	Females reported that last sex was more recent than males (possibly telescoping?); however, reliability was good for time since last intercourse with 63.2% and 65% of concordant and HIV discordant couples agreeing to a 3 day window.
Helleringer (2011) <sup>32</sup>	Research	845 relationships	Reliability; Inter-partner Agreement of agreeing that they were partnered	Whether or not participants were partnered	Interviewer-assisted, independent interview	Agreement on whether or not partnerships were named in each others' interviews was low in non-marital relationships, and higher in ongoing relationships. IPA was associated with duration on partnership and the number of other partners a participant had outside of the partnership. Low partnership agreement showed significant bias in sensitivity analysis situations.
Ellish (1996) <sup>38</sup>	Research	162 heterosexual partnerships	Reliability	Frequency of sexual acts and condom use	Interviewer-assisted, independent interview	Agreement was high for married couples; agreement lower for number of acts where one or both partners reported more frequent intercourse. Participants having been diagnosed with an STD was associated with less agreement on sex frequency.

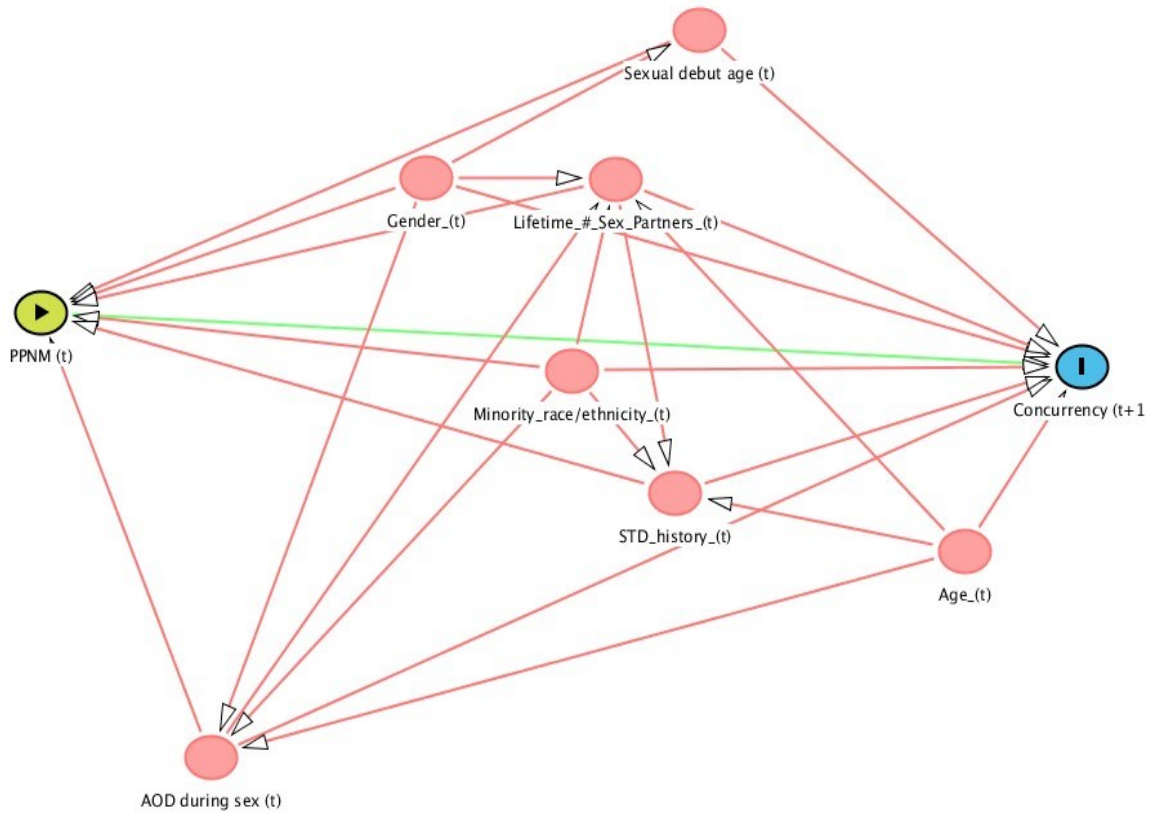
Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Ochs (1999) <sup>70</sup>	Research	70 couples	Reliability	68 sexual behaviors (whether or not they occurred)	Either interviewer-assisted or computer-assisted, independent interview with techniques that addressed question clarity	Moderate to substantial agreement on which specific sex acts occurred in relationship.
Upchurch (1991) <sup>72</sup>	Research	71 heterosexual couples, STD clinic attendees	Reliability, Mean differences in frequencies	Frequency and type of sexual behaviors	Individual reports; Used calendar in interviews to assist with recall	Agreement high on frequency and type of sexual behaviors for the past 30 days (recent behaviors)
Van Duynhoven (1999) <sup>69</sup>	Research	288 dyad members	Test Re-Test Reliability (between index subjects interviewed by different medical staff); And Inter-Partner Agreement	Various factors, age at intercourse, frequency of sex, number of sex partners, history of STD	Interviewer-assisted, Individual report	Overall, high reliability and inter-partner agreement, though frequency of sex was unreliable,



Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Carballo Dieguez (1999) <sup>66</sup>	Research	75 HIV serodiscordant MSM	Reliability; Test-Retest Reliability; Qualitative Reasons for Discrepancy	Whether or not certain penetrative acts occurred; condom use	Individual reports; Joint assessment with both members of couple and an interviewer (qualitative)	Used joint assessment of sexual behavior data to explore reasons for discrepancies, found that reasons for discrepancy included infrequency incidents, inaccurate specification of time frame, differing definitions of “sex”, technical differences.
Harris (2010) <sup>35</sup>	Research	Married couples	-	-	-	Discuss concepts related to collaborative recall and remembering: collaborative inhibition, retrieval strategy disruption hypothesis (interviewing together interrupts other person from remembering). For autographical events, for all couples, there was at least one autographical task that they collaborated on to recall – they did this dynamically and interactively. What happens during collaborative recall: cross-cuing—interactive process where couple recalls information that both had forgotten.
Hageman (2009) <sup>79</sup>	Research	779 cohabitating couples	Reliability		Interviewed separately	Agreement high for: type of marriage; relationship type (monogamy, e.g.); whether or not condoms were used. Agreement was low for: perceived partner non-monogamy, and other relationship-level perceptions.
Seage (1992) <sup>45</sup>	Research	155 MSM dyads from research trial	Reliability	Ever/Never, and Frequency of Sex Acts	Interviewed separately	Overall, agreement fairly high (kappa>0.7) for reported sexual activities among MSM. However, they varied significantly based on couple's drug and alcohol use.

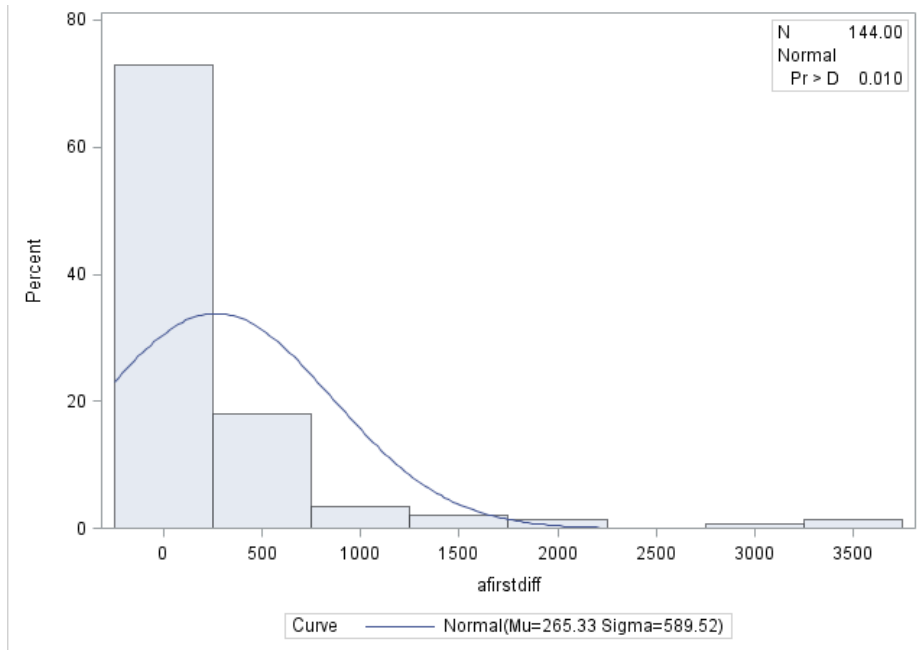
Author (Year)	Article Type	Population	Measures	Variables Examined	Data Collection Method	Relevant Findings
Witte (2007) <sup>44</sup>	Research	217 dyads	Reliability	Had sex in 90 days (separately for oral, anal or vaginal)	Interviewed separately	Fair to substantial agreement on factors related to risk behavior; but poor to fair on concurrent sexual behaviors and drug and alcohol use. Factors associated with discordant reporting were duration of couple's relationship, level of relationship satisfaction, marital status, HIV status, ethnicity and age.
Morris and O'Gorman (2000) <sup>74</sup>	Research	-	Sensitivity Analysis /Robustness	Dates of Sex, as they relate to Concurrency	-	Overall, reporting errors are likely to create a slight positive in the estimation of concurrency, and a slight negative in the duration of overlap.
Seal (1997) <sup>75</sup>	Research	117 college dating couples	Reliability	When sex occurred, variety of sexual acts, protective behaviors (e.g., discussion of safer sex), and perceptions	Structured, self-administered questionnaire, separately for each partner	Agreement of what types of sex had occurred was good, and agreement for dates elapsed since sex occurred was good for markers such as "first met" or "first date" but less agreement for "casually dating" "steadily dating" or "exclusively dating". Greater agreement for couples where male partner was younger, where men were not sexually active prior to the current relationship.
Jaccard (2004) <sup>31</sup>	Research	285 heterosexual young adults	Test- Retest Reliability	Number of sex partners	Self-administered questionnaire	Those who were monogamous had more accurate reports; accuracy better for shorter recall periods

### APPENDIX 3.1: DIRECTED ACYCLIC GRAPH

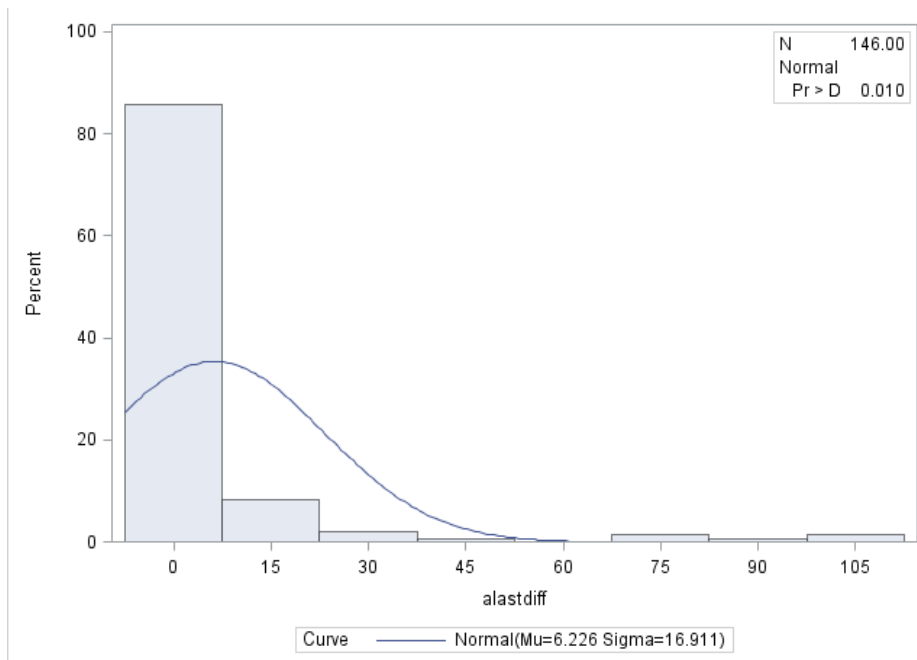


## APPENDIX 3.2: DISTRIBUTION OF INTER-PARTNER DIFFERENCES

Inter-Partner Differences, in Days, on Date of First Sex



Inter-Partner Differences, in Days, on Date of Last Sex



#### APPENDIX 4.1: MANUAL REVIEW OF INCIDENT CONCURRENCY CASES

Code	Scenario	Determination	Frequency
1	Participant perceives PPNM with just one partner, then ends that partnership before beginning another	Sequential	1
2	Participant continues a partnership that has PPNM, then adds other partnerships that overlap later in the interval	Sequential	8
3	Participant continues partnership in which they perceive PPNM, and add ones earlier in the interval	Possibly Sequential	13
4	Participant has concurrency first, <i>then</i> PPNM	Non-sequential	0
5	Participant takes another partnership (concurrency), but it is the new partnership(s) which have PPNM	Non-sequential	11
99	Didn't have PPNM in the interval		51
100	Missing PPNM data on continuing partner/ Cannot be determined		8
Total			92

## APPENDIX 4.2: AGREEMENT IN PERCEIVED PARTNER NON-MONOGRAMY

		Partner Reports ("Gold Standard")		
		Partner reports Non-Monogamy	Partner reports Monogamy	
Participants' Perception ("Test")	Perceive Partner Non- Monogamy (PPNM)	"Correct" a	"Incorrect" b	<i>Total Perceiving Partner Non- Monogamy</i>
	Perceive Partner Monogamy (No PPNM)	"Incorrect" c	"Correct" d	<i>Total Perceiving Partner Monogamy</i>
		<i>Total Reporting Non-Monogamy</i>	<i>Total Reporting Monogamy</i>	

Measure of Comparison	Calculation	Estimates from Literature
Sensitivity	$a/(a+c)$	26% <sup>60</sup> – 40% <sup>59</sup>
Specificity	$d/(b+d)$	61% <sup>43</sup> – 86% <sup>60</sup>
Positive Predictive Value	$a/(a+b)$	46% <sup>43</sup> – 69% <sup>59</sup>
Negative Predictive Value	$d/(c+d)$	73% <sup>43</sup> – 82% <sup>59</sup>

### APPENDIX 4.3: RATIONALE FOR INTERVENTIONS RELATED TO PARTNER PERCEPTIONS

Cell	Explanation	Types of Outcomes Possibly Linked to This Cell	Overall STI/HIV Risk for Participant
a	Participant's perception of partner non-monogamy is validated by partner's report; they think partner is non-monogamous, and partner is, based on report (correctly assessing partner risk; akin to "True Positive")	<ul style="list-style-type: none"> <li>May reflect mutual non-monogamy, or explicit partner non-monogamy</li> <li>May lead participant to break-up with partner, if monogamy was important to participant</li> <li>May lead participant to use condoms with partner</li> <li>May lead participant to initiate concurrency (reactive concurrency)</li> </ul>	<p>Lower, if: condoms, or break-up</p> <p>Medium, if: mutual non-monogamy where condoms are used with additional partners, but not main partner (for which PPNM exists)</p> <p>Higher if reactive concurrency<sup>17</sup>, or not using condoms with partner(s)</p>
b	Participant's perception of partner non-monogamy is <u>not</u> validated by partner's report; they think partner is non-monogamous, but the partner is not, based on report (overestimating partner risk; akin to "False Positive")	<ul style="list-style-type: none"> <li>May lead participant to break-up with partner, if monogamy was important to participant</li> <li>May lead participant to use condoms with partner</li> <li>May lead participant to initiate concurrency (reactive concurrency)</li> </ul>	<p>Lower if condoms or break-up.</p> <p>Higher if reactive concurrency<sup>17</sup></p>
c	Participant's perception of partner monogamy is not validated by partner report; they think partner is monogamous, but partner is non-monogamous, based on partner report (underestimating partner risk; akin to "False Negative")	<ul style="list-style-type: none"> <li>Participant is unaware of partner behavior, and this may lead partner to have exposure to STI risk without having taken necessary risk-reducing behaviors</li> </ul>	Higher risk <sup>60</sup>
d	Participant's perception of monogamy is validated by partner report; they think partner is monogamous, and partner is monogamous, based on partner report (correctly assessing partner risk; akin to "True Negative")	<ul style="list-style-type: none"> <li>Mutual monogamy ("open relationships") along with regular partner testing, is comparatively medium-risk<sup>17</sup>, compared with other cells</li> </ul>	Lower Risk

#### APPENDIX 4.4: SENSITIVITY AND SPECIFICITY OF PERCEIVED PARTNER NON-MONO GAMY

Author (Year)	Population	N	Overall % of Confirmed Non-Monogamy/ Concurrency			Overall, % Perceiving Partner to be Non-Monogamous			<i>Of Those Who Were Monogamous:</i> % Partners Perceiving Monogamy ("Specificity")			<i>Of Those Were Non- Monogamous:</i> % Partners Perceiving Non-Monogamy ("Sensitivity")		
			All	Male	Fem.	All	Male	Fem.	All	% Male	% Fem.	All	% Male	% Fem.
Swartzend ruber (2012) <sup>59</sup>	Young adults from OBGYN university clinics	296	29%	34%	24%	17%	14%	24%	83%	85%	82%	40%	41%	38%
Drumright (2004) <sup>60</sup>	Young adults (18-25) from STD/family planning clinics	96	32%			16%			86%			26%		
Stoner (2003) <sup>63</sup>	Adults (14-45) with chlamydia gonorrhea in STD clinic	151*	45%											
Lenoir (2006) <sup>43</sup>	Adolescents (14-19) presenting in teenage clinic or STD clinic	90	29%			23%	17%	29%	61%	65%	57%	37%	42%	23%
Witte (2010) <sup>62</sup>	Adults(18-55) participating in a clinical trial	217		21%	16%		11%	37%						



# APPENDIX 4.5: POSITIVE AND NEGATIVE PREDICTIVE VALUE OF PERCEIVED PARTNER NON-MONO GAMY

Author (Year)	Population	N	Overall % of Confirmed Non-Monogamy/ Concurrency			Overall, % Perceiving Partner to be Non-Monogamous			Of Partners Perceiving Monogamy: % Partners Reporting Monogamy ("Negative Predictive Value")			Of Partners Perceiving Non-Monogamy: % Partners Reporting Non-Monogamy ("Positive Predictive Value")		
			All	Male	Fem.	All	Male	Fem.	All	% Male	% Fem.	All	% Male	% Fem.
Swartzen druber (2012) <sup>59</sup>	Young adults from OBGYN university clinics	296	29%	34%	24%	17%	14%	24%	82%	82%	81%	69%	66%	72%
Drumright (2004) <sup>60</sup>	Young adults (18-25) from STD/family planning clinics	96	32%			16%								
Stoner (2003) <sup>63</sup>	Adults (14-45) with chlamydia gonorrhea in STD clinic	151	45%											
Lenoir (2006) <sup>43</sup>	Adolescents (14-19) presenting in teenage clinic or STD clinic	90	29%			23%	17%	29%	73%	84%	63%	46%	62%	20%
Witte (2010) <sup>62</sup>	Adults(18-55) participating in a clinical trial	217		21%	16%		11%	37%						

# **APPENDIX 6.1: PERCEIVED PARTNER NON-MONOGAMY AND CONCURRENCY**

Characteristic	Index Participant (N=151)		Partner Participant (N=151)	
	N	%	N	%
Perceived Partner Non-Monogamy (PPNM)				
Yes	28	18.5	22	14.6
No	121	80.1	125	82.8
Missing	2		4	
Concurrent Sexual Partnerships <sup>a</sup>				
Overlap in partnership dates	33	21.9	-	-
Current concurrency at interview	13	8.6	8	5.3

a      Concurrency type percentages are out of all participants

## APPENDIX 6.2: ACCURACY OF PERCEIVED PARTNER NON-MONGAMY POPD STUDY

Characteristic	Index Participant's Behavior (N=151)		Partner Participant's Behavior (N=151)	
	N	%	N	%
<b>Concurrency (Overlap)<sup>a</sup></b>				
Yes	33		-	-
Partner perceives concurrency	9	27.5	-	-
No	114		-	-
Partner perceives concurrency	13	11.4		
<b>Concurrency (Current Concurrency)<sup>b</sup></b>				
Yes	13		8	
Partner perceives concurrency	3	23.1	5	62.5
No	134		141	
Partner perceives concurrency	19	14.2	23	16.3
<b>Perceived Partner Non-Monogamy (PPNM)</b>				
<b>Yes</b>	<b>22</b>		<b>28</b>	
Partner is non-monogamous, based on overlap <sup>a</sup>	9	40.9	-	-
Partner is non-monogamous, based on current concurrency <sup>b</sup>	3	13.6	5	17.9
<b>No</b>	<b>125</b>		<b>121</b>	
Partner is non-monogamous, based on overlap <sup>a</sup>	24	19.2	-	-
Partner is non-monogamous, based on current concurrency <sup>b</sup>	10	8.0	7	5.8
Missing	4		2	

a Concurrency based on overlap in reported sexual partnership dates

b Current concurrency corresponds to the participant reporting more than 1 ongoing sexual partnership at the time of interview

### APPENDIX 6.3: PERCEIVED PARTNER NON-MONOGAMY LITERATURE SUMMARY

	Range from Literature	Project on Partner Dynamics			
		Index's behavior, vs. Partner's Perception		Partner's behavior, vs. Index's Perception <sup>a</sup>	
		Concurrent based on overlap <sup>a</sup>	Concurrent based on current concurrency <sup>b</sup>	Concurrent based on overlap <sup>a</sup>	Concurrent based on current concurrency <sup>b</sup>
<b>Sensitivity</b>	26% <sup>60</sup> – 40% <sup>59</sup>	27.5%	23.1%	-	62.5%
<b>Specificity</b>	61% <sup>43</sup> – 86% <sup>60</sup>	88.6%	85.8%	-	83.7%
<b>Positive Predictive Value</b>	46% <sup>43</sup> - 69% <sup>59</sup>	40.9%	13.6%	-	17.9%
<b>Negative Predictive Value</b>	73% <sup>43</sup> - 82% <sup>59</sup>	80.8%	92.0%	-	94.2%

a When partner participants were recruited into the POPD study, they were only asked about sexual partnership information for the index partner that recruited them; thus, it was not possible to calculate overlap in reported partnerships for partner participants.

b Concurrency based on overlap in reported sexual partnership dates

c Current concurrency corresponds to the participant reporting more than 1 ongoing sexual partnership at the time of interview

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