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# Sexual Concurrency and Contraceptive Use Among Young Adult Women

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## Abstract

Leveraging 2.5 years of weekly data from the Relationship Dynamics and Social Life Study, we investigate the relationship between young women's sexual concurrency and their contraceptive behavior. Specifically, we (1) examine whether young women changed their contraceptive use when switching from one to multiple concurrent sexual partners in the same week; (2) explore the uniformity of contraceptive responses to concurrency across relationship context; and (3) compare the contraceptive behaviors of never-concurrent women with those of ever-concurrent women in weeks when they were not concurrent. Nearly one in five sexually active young women had sex with two or more people in the same week. When they were concurrent, these women's odds of using any contraception increased threefold, and their odds of using condoms increased fourfold. This pattern of contraceptive adjustments was the same across relationship characteristics, such as duration and exclusivity. Yet when they were not concurrent, ever-concurrent women were less likely to use any contraception and used condoms less consistently than women who were never concurrent. We discuss these findings in the context of ongoing debates about the role of sexual concurrency in STI transmission dynamics.

**Keywords** Sexual concurrency · Contraception · Sexual health

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## Introduction

Scholars often conceptualize sexual concurrency—that is, having overlapping sexual partnerships—as one of the central behaviors contributing to the spread of sexually transmitted infections (STIs) (Eaton et al. 2011; Gorbach et al. 2005; Kretzschmar and Morris 1996). The underlying logic is that overlapping partnerships connect multiple individuals at one time, forming a sexual *network* as opposed to a sexual *dyad*, thereby increasing the exposure of healthy individuals to infected ones (Helleringer and Kohler 2007; Helleringer et al. 2014; Morris 2010; Morris and Kretzschmar 1997). Although early thinking about concurrency's role in STI epidemics was based on mathematical simulations (Morris and Kretzschmar 1997) and motivated by the HIV epidemic in sub-Saharan Africa (Helleringer et al. 2014; Kretzschmar and Caraël 2012; Morris et al. 2010; Reniers and Watkins 2010; Sawers and Stillwaggon 2010), survey-based studies in both sub-Saharan Africa and the United States have found that compared with individuals with serially monogamous relationships, individuals with concurrent relationships are indeed more likely to transmit STIs to their partners, including HIV, syphilis, and chlamydia (Helleringer et al. 2009; Koumans et al. 2001; Potterat et al. 1999).[1]

Higher rates of transmission within concurrent couples are somewhat puzzling because although concurrency increases an individual's risk of transmitting an STI via going back and forth between partners over time, concurrency does not increase that individual's risk of infection above and beyond having sex with those same partners sequentially (Morris 2010). Moreover, at least some individuals may use condoms to prevent the risk of STI transmission when they have concurrent partnerships (Gorbach et al. 2002).

Surprisingly few studies have examined condom use as it corresponds to concurrency, leaving open important questions about variation in concurrent individuals' condom use over time and differences in average condom use between ever- and never-concurrent individuals. These unanswered questions reflect a long-standing reliance on cross-sectional data sources, which has stymied prior research in three key ways. First, without frequent, repeated assessments of sexual behavior and contraceptive use, studies have been unable to determine whether condom use changes with concurrency. Second, in the absence of time-varying information on relationship status and dynamics, previous research has been unable to assess whether partnership context at concurrency conditions such a change (Gorbach et al. 2002). Third, and relatedly, without repeated measurement from the same individuals, studies have been unable to disentangle the effects of concurrency from unobserved differences between ever- and never-concurrent individuals that may also be related to STI transmission.

In this study, we use 2.5 years of weekly panel data collected among 758 sexually active, young adult women in one Michigan county to make three important contributions to existing scholarship. First, we investigate whether and how women changed their contraceptive use when they went from having sex with one person to having sex with multiple people in the same week. To account for the potential selection of higher-risk

[1] Using a sexual network survey, Helleringer et al. (2009) found that concurrent partnerships are more likely to be HIV sero-discordant than serial partnerships in sub-Saharan Africa. From this, they concluded that concurrent partnerships are at greater risk of transmission.

individuals into concurrency, we estimate these models using person fixed effects. For instance, if an unobserved stable trait (such as impulsivity) simultaneously contributes to the likelihood of being concurrent and the likelihood of (not) using condoms, our fixed-effects strategy would account for this by comparing condom use by the same woman when she was concurrent with when she was not. Second, we examine uniformity in contraceptive responses across relationship contexts, also using models with person fixed effects. Third, we examine systematic differences in contraceptive use between never- and ever-concurrent women in weeks when they were not concurrent while also examining differences between concurrent and not concurrent weeks among ever-concurrent women using models with random effects. These models allow for the simultaneous estimation of between-group and within-woman differences and thus allow us to describe broader behavioral differences related to concurrency that may affect individuals' sexual health as well as STI transmission dynamics at the population level. They further facilitate a comparison of the magnitude of the effects of concurrency as a trait of individuals (e.g., ever-concurrent) with the magnitude of the effects of concurrency as a behavior (e.g., concurrent this week).

## Existing Assessments of Concurrency

Accurately understanding the relationship between concurrency and contraceptive use[2] requires repeated and time-specific measurements of sex, contraception, and relationship context from a socially and demographically diverse sample. However, most research on sexual concurrency has relied on cross-sectional data from the National Survey of Family Growth (NSFG) (Adimora et al. 2011), the Demographic and Health Surveys (DHS) (Adimora et al. 2011; Reniers and Tfaily 2012), or convenience samples of STI and obstetric clinic patients (Andrinopoulos et al. 2006; Gorbach et al. 2002; Nelson et al. 2007; Nunn et al. 2014; Rosengard et al. 2005; Sangi-Haghpeykar et al. 2003); or on longitudinal data collected at wide intervals, such as the National Longitudinal Survey of Adolescent and Adult Health (Add Health) (Ford et al. 2002; Kelley et al. 2003). In these surveys, concurrency is typically measured by having respondents identify the first and last date of intercourse with individual partners in the last year, or by asking respondents whether or how many additional sexual partners they had during their most recent relationship. Because of the potential for recall bias, both methods suffer from underreporting (Helleringer et al. 2011), although asking individuals to remember specific dates yields more measurement error and missing data than asking them to count partners (Glynn et al. 2012; Manhart et al. 2002; Nelson et al. 2007; Nunn et al. 2014). Moreover, neither method necessarily reveals whether an individual had sex with both partners within a short window of time—an issue further complicated by coital dilution, meaning reductions in per partner sexual frequency with the addition of concurrent partnerships (Blower and Boe 1993; Gaydosh et al. 2013; Sawers et al. 2011).

Identifying sexual concurrency within a narrow timeframe is important because the shorter the window between partners, the less time a newly infected individual has to

[2] Although we are primarily interested in the relationship between concurrency and condom use, we refer to contraceptive use more broadly because condom use may be determined jointly with use of other methods, depending on whether individuals are additionally concerned about unwanted pregnancy.

present STI symptoms, get tested, or learn of the test results (Boily et al. 2012). In addition, identifying concurrency at a certain point in time allows researchers to better describe the relationship contexts in which it immediately occurs—for instance, whether women are in an unstable point in their relationship. Characteristics such as these may contribute to heterogeneity in contraceptive responses by creating incentives to use (or not use) contraception and/or by affecting perceived STI risk (Gorbach and Holmes 2003; Kretzschmar and Caraël 2012; Kretzschmar et al. 2010).

Conceptualizing the link between concurrency and sexual health at the population level is further complicated by the possibility that concurrency proxies for unobserved differences between individuals. For instance, as described earlier, concurrency does not increase the risk of STI infection more than having sex with the same number of partners sequentially (Morris 2010). Yet, in the United States, recently concurrent individuals tend to have higher rates of STIs, including human papilloma virus (HPV), gonorrhea, and chlamydia (Gorbach et al. 2005; Javanbakht et al. 2010; Rosenberg et al. 1999; Washington et al. 2018). Differences in STI rates may thus reflect differences in condom use, and potentially other behaviors, between ever- and never-concurrent individuals (Adimora et al. 2011; Hess et al. 2012; Kalichman et al. 2007). These differences matter for two reasons. First, people bring their sexual history with them to relationships. If ever-concurrent people are more likely to engage in behaviors that increase their risk of STI infection, then they may also be more likely to become STI carriers. By extension, their partners may also be more likely to become infected than had they partnered only with never-concurrent individuals, *assuming no or inconsistent condom use*. Second, certain STIs increase the risk of concomitantly becoming infected with others. For example, infection with syphilis or the herpes simplex virus type 2 (HSV-2) increases the risk of becoming infected with HIV (Fleming and Wasserheit 1999; Freeman et al. 2006). If concurrent individuals are more likely to be infected with at least one STI, then they should also be at greater risk of becoming infected with another. Correspondingly, they may be at higher risk of transmitting multiple STIs than nonconcurrent individuals. Simultaneously understanding within-woman changes in condom use specifically *while* concurrent and cross-group behavioral differences between ever- and never-concurrent women is thus critical to clarifying the potential role that concurrency plays in STI transmission dynamics at the population level.

## Concurrency, Relationship Context, and Contraceptive Use

Among young adults in the United States, concurrency may occur in a variety of different relationship contexts. These include casual "hook-ups" with more than one partner (Manning et al. 2006; Paul et al. 2000; Sassler 2010); ongoing nonmonogamous relationships; cheating while in allegedly exclusive relationships (Wilkins and Dalessandro 2013); and *churning*, or transitioning between partners (Ford et al. 2002; Halpern-Meekin et al. 2013; Manning et al. 2014; Sassler 2010). These different contexts are important because contraceptive use is often negotiated within and influenced by relationships (Barber et al. 2013; Kusunoki forthcoming; Kusunoki and Upchurch 2011; Manlove et al. 2007; Manning et al. 2014), not only because relationship dynamics affect fertility desires (Weitzman et al. 2017) and contraception is an

impediment to fertility, but also because contraception—especially condoms—can be perceived as a hindrance to intimacy and pleasure, and/or a sign of mistrust or lack of commitment (Brady et al. 2009; Higgins et al. 2009; Tavory and Swidler 2009).

One relationship characteristic closely related to condom use is exclusivity. In exclusive relationships, both partners agree to have sex only with each other. This reduces the presumed amount of risk for STI transmission within the relationship (except when one or both partners are already infected) (Goldenberg et al. 2015; Lear 1995). As such, condoms may be viewed as a sign of mistrust or may signal a breach of trust in exclusive relationships (Sterk et al. 2004; Tavory and Swidler 2009). To avoid signaling this breach, some women may opt not to use condoms with their primary partners when they are cheating on them, although they may still use condoms with secondary partners to protect their primary relationship from outside infection (Gorbach et al. 2002). In contrast, in nonexclusive relationships, the potential for additional partners creates an ongoing element of risk. In light of this risk, both partners may agree to use condoms regularly (Goldenberg et al. 2015; Gorbach et al. 2002). Thus, women may be more likely to use condoms when they are concurrent and in nonexclusive relationships than when they are concurrent and in exclusive relationships.

Beyond exclusivity, relationship transitioning—exiting one relationship while simultaneously entering another—may diminish the likelihood a woman uses condoms in response to concurrency (Gorbach et al. 2002). There are several reasons for this. One is that when women are transitioning between partners, they may feel intimately connected to both of them. Given that condoms are often viewed as an impediment to intimacy, women may be less likely to use condoms when they are concurrent and transitioning from one exclusive relationship to another than when they are concurrent but not transitioning (Gorbach et al. 2002). Another possibility is that because a woman is at risk of transmitting to or acquiring an STI from a given partner only while she is still sexually active with him, she may perceive these risks as lower when she anticipates separating. Anticipatory separation may accordingly reduce the extent to which women believe they need to offset any risk with condoms.

Relationship duration and instability may also moderate the effect of concurrency on condom use. If longer and more stable relationships tend to be more serious or are perceived as more committed, then women may feel a greater obligation to protect their primary partners (Kusunoki and Upchurch 2011). If so, then condom use with secondary partners may be greater when women have been with the same primary partner longer and/or when they are in stable relationships (e.g., they have not previously broken up and then reconciled).

## Current Study: Leveraging Weekly Data From the Relationship Dynamics and Social Life Study

Better disentangling the relationship between concurrency and contraceptive use requires simultaneously answering three questions: Do women change their contraceptive behaviors when they are concurrent? If so, how uniform are these responses across relationship context? And how do the contraceptive behaviors of ever- and never-concurrent women differ when not concurrent? Longstanding data limitations have prevented past scholarship from answering these questions in tandem. In this study, we

leverage unique longitudinal data from the Relationship Dynamics and Social Life Study (RDSL; Barber et al. 2016a) to jointly answer all three questions.

RDSL data provide 2.5 years of weekly accounts of the sexual and contraceptive behaviors of 1,003 young adult women who were 18–19 years old and residing in one Michigan county at the start of the study (in 2008–2009).[3] These women were randomly selected from the Michigan Secretary of State's database of driver's licenses and personal ID cards. Although Michigan is not representative of the United States as a whole, it does mirror much of the United States in terms of key demographic measures, such as cohabitation and marriage, age at first birth, nonmarital and teen childbearing, and completed family size (see Lesthaeghe and Neidert 2006 for more details). Moreover, the RDSL is consistent with national averages among women of the same age in terms of high school and postsecondary school enrollment, age distribution, employment rates, marriage, and residential arrangements (Clark 2018). The one notable way in which the RDSL sample is distinct is with respect to race/ethnicity: compared with estimates of the racial distribution in the United States as a whole, the RDSL includes twice as many African American women and half as many Hispanic women (Clark 2018).

The RDSL began with a 50-minute, in-person baseline survey that gathered information on respondents' demographic background and sexual and reproductive history. Upon completion, respondents were invited to participate in the follow-up portion of the study, which included five-minute surveys completed online or via telephone every week for 2.5 years. Ninety-nine percent of respondents agreed to participate in weekly surveys after the baseline survey. Seventy-eight percent of respondents remained in the study for 1.5 years or more; 63 % remained in the study for the full 2.5 years (Barber et al. 2016b).[4]

Each week, respondents were asked a series of questions to determine whether they were in any type of relationship (broadly construed)[5] and, if so, to provide that partner's initials. Respondents who reported having multiple partners provided the initials of their most significant partner. When women were partnered, their weekly survey included questions about their current relationship dynamics, including vaginal intercourse, exclusivity, conflict, violence, and instability with their primary partner in the preceding week, and about whether women had vaginal intercourse with anyone else that week as well. Weekly surveys also included questions about contraception—specifically, whether respondents did "anything that can help people avoid becoming pregnant." When respondents said "yes," they were asked a series of questions about their use of specific methods (pills, patch, vaginal ring, contraceptive shot, implant, IUD, rhythm, condom, diaphragm, cervical cap, spermicide, withdrawal, and "morning-after pill") and their consistency of use that week. Questions about contraceptive methods were not partner-specific: although contraceptive use, type, and consistency can be identified in a given week, variation in use cannot be linked to specific partners if a respondent reported having sex with two or more people and did not use

[3] The response rate for the baseline survey was 84 %. Women who were temporarily residing outside the county in order to attend school or to acquire job training were also included.

[4] Attrition rates differed by race and education at baseline. African American respondents and respondents who had never attended college completed an average of 11 and 12 fewer weekly surveys, respectively, than did white respondents and respondents who had at least some college education.

[5] These relationships ranged from an online boyfriend to a one-night stand to a husband, and everything in between.

contraception consistently.[6] Every three months (12 weeks), respondents were asked to provide information on their psychological orientation toward sex and contraception and to update their educational information. A randomized experiment conducted during the RDSL found little evidence of panel conditioning bias (Barber et al. 2012). In other words, repeatedly answering questions about relationships, sex, contraception, and attitudes had little to no effect on women's reported behavior or outlook.

Because RDSL data not only allow us to identify which women were ever sexually concurrent during a 2.5-year period but more specifically *when* they were concurrent, they offer us four distinct advantages. First, they allow us to observe whether women changed their contraceptive behavior when they were concurrent, thus revealing whether women took precautions to avoid STI transmission. Second, they facilitate an investigation of the relationship contexts surrounding concurrency and whether these contexts moderated the effects of concurrency on condom use. Third, they allow us to determine whether, on average, the contraceptive behavior of never-concurrent women differed from that of ever-concurrent women in weeks when they were not concurrent. Comparing the contraceptive behaviors of ever- and never-concurrent women in the absence of current concurrency illuminates other systematic differences that could contribute to disparate sexual health trajectories. Fourth, they afford us the opportunity to simultaneously compare contraceptive use between never-concurrent women, ever-concurrent women when they were not concurrent, and ever-concurrent women when they were concurrent, thus conveying a holistic picture of the relationship between concurrency and contraceptive use.

## Data and Methods

### Sample

Given our interest in sexual concurrency and its relationship to contraceptive use, we focus our attention on respondents who were ever sexually active during the RDSL study and who completed three or more journals ($N$ = 758).[7] Specifically, we treat weeks when respondents were sexually active as the unit of analysis ($N$ = 20,069).[8]

### Measures

*Concurrency*

We rely on a weekly dichotomous indicator of concurrency, which was determined by whether respondents had vaginal intercourse with their primary partner and with someone else in the preceding week (vs. sex with only one person that week). Given that women may continue to adjust their contraceptive use in weeks following concurrency, we also create a one-week lagged measure. This necessitates including additional

[6] This was the case in one-third (32 %) of weeks in which women reported having sex with two or more people.

[7] Respondents were first asked about sexual intercourse at the second journal. Our inclusion of one-week lagged variables in our final models, as described later, necessitates having completed three or more journals.

[8] The survey asked about only heterosexual vaginal intercourse.

dichotomous indicators of whether respondents were in a relationship in the prior week and, if so, whether they had the same primary partner.[9]

One in five respondents had sex with two or more people in the same week during the study period (analysis not shown). However, instances of concurrency were rare: among women who were concurrent, 49 % were concurrent for only one week, and 73 % were concurrent for two weeks or less (Fig. 1). Approximately one-half of concurrency (49 %) occurred within nonexclusive relationships; the other one-half occurred as cheating while in exclusive relationships (51 %) (Fig. 2). Only one-third of concurrency (32 %) occurred during relationship transitions (in which respondents reported different primary partners in two consecutive weeks) (Fig. 2).[10] On average, concurrency occurred 10 weeks (74 days) into a primary relationship and after 0.83 prior breakups with that partner (analysis not shown).

Many of the weeks that we define as concurrent (e.g., weeks in which women had sex with more than one person) likely capture embedded concurrency (McGrath 2010)—that is, situations in which a woman had sex with Partner A, followed by Partner B, and then with Partner A again (in that same week or in conjunction with other weeks). However, because the survey did not assess the frequency and order of intercourse with each partner in a given week, we cannot be certain. Therefore, as a sensitivity test, we also examine whether the effects of concurrency differ depending on whether it occurred in the middle of a three-week or longer spell with the same primary partner ($n$ = 174 weeks, 49 % of those that were concurrent). The results of this sensitivity test are discussed after our main models.

### *Contraception*

Contraception is measured weekly with dichotomous indicators of whether respondents used any form of contraception, used condoms specifically, used a hormonal method, and used condoms every time they had sex in a given week (if at all). Respondents used contraception in 80 % of the weeks they had sex (Table 1). They used condoms specifically in 45 % of weeks when they had sex and used contraception (Table 1).

### *Relationship Characteristics*

Given that relationship characteristics may influence contraceptive use (Barber et al. 2010, 2013; Kusunoki and Upchurch 2011; Kusunoki et al. 2018; Manning et al. 2009, 2012), we control for relationship exclusivity; relationship duration (measured in weeks); a woman's number of prior breakups with her current partner; and her number of previous weeks with her current partner that included sex, fighting, and violence (separately).[11] Because the RDSL included questions about the dynamics of only primary relationships, these measures pertain exclusively to primary relationships.

[9] We also test two- and four-week lagged measures of concurrency. The results lead to substantively similar conclusions (available upon request).

[10] Nontransitioning weeks include weeks when the respondent had either the same primary partner in the immediately preceding and following weeks, no partner in the immediately preceding and following weeks, or some combination thereof.

[11] For relationships that were ongoing at baseline, this measure includes time together before RDSL participation.

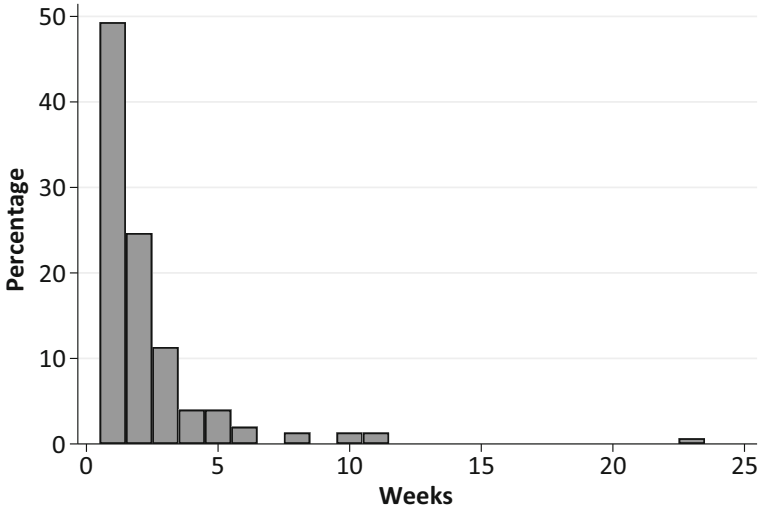


**Fig. 1** Number of weeks in which respondents were concurrent, among those who were ever concurrent. $N$ = 150 respondents who were ever concurrent during the study.

*Sexual and Reproductive History*

Because sexual history may affect contraceptive use, we control for respondents' cumulative number of sex partners during the study, ranging from 1 to 13. Likewise, because pregnancy may be related to both sex and contraception, all models control for whether a respondent was pregnant in a given week and her number of preceding pregnancies (including those before baseline).

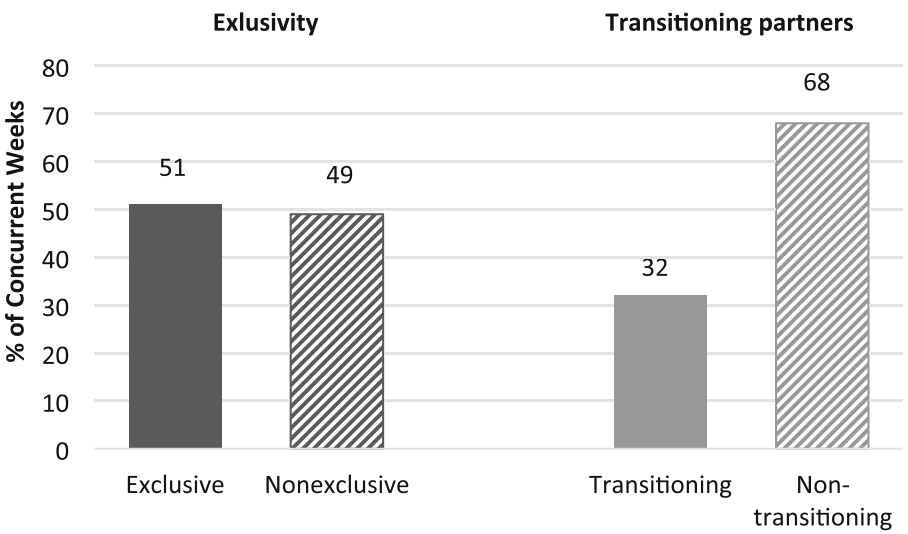


**Fig. 2** Primary relationship context at concurrency. $N$ = 352 weeks in which respondents were concurrent. *Exclusivity* is defined as an agreement between partners to be only in one special relationship with each other. *Transitioning partners* is defined as having a different primary partner in the immediately preceding or following week.

**Table 1** Descriptive statistics

| | Number of Sexually Active Weeks | Proportion/ Mean | SD |
|---|---|---|---|
| Concurrency | | | |
| Concurrent (had sex with ≥2 people in the same week) | 20,059 | .02 | |
| Contraceptive Use | | | |
| Used any contraception | 20,059 | .80 | |
| Used condoms if used any contraception | 15,956 | .45 | |
| Used only condoms | 15,956 | .25 | |
| Used condoms if also used a hormonal method | 8,749 | .35 | |
| Used a condom every time had sex if only used condoms | 3,295 | .83 | |
| Used a condom every time had sex if used condoms and hormonal | 2,871 | .70 | |
| Relationship Characteristics | | | |
| In an exclusive relationship | 20,059 | .91 | |
| Transitioning partners (different partner than preceding or following week) | 20,059 | .05 | |
| Relationship duration (0–110 weeks) | 20,059 | 7.44 | 15.34 |
| Number of prior breakups with current partner (0–17) | 20,059 | .37 | 1.05 |
| Number of prior weeks: | | | |
| Had sex with current partner (0–124) | 20,059 | 23.20 | 23.64 |
| Fought with current partner (0–114) | 20,059 | 7.51 | 11.75 |
| Hurt by current partner (0–34) | 20,059 | .54 | 2.40 |
| Sexual and Reproductive History | | | |
| Cumulative number of sex partners in study (1–13) | 20,059 | 1.80 | 1.52 |
| Pregnant | 20,059 | .10 | |
| Cumulative number of pregnancies in lifetime (0–10) | 20,059 | .53 | .97 |
| Psychological Orientation Toward Sex and Contraceptive Use | | | |
| Perceived self-efficacy (0–100) | 20,059 | 78.85 | 19.57 |
| Opposition toward contraception (0–28) | 20,059 | 5.97 | 19.57 |
| Approval of casual sex (1–5) | 20,059 | 2.40 | 3.83 |
| Demographic Background | | | |
| Education | | | |
| <High school diploma | 20,059 | .09 | |
| Graduated high school, not enrolled | 20,059 | .27 | |
| Enrolled in or graduated college | 20,059 | .64 | |
| Age (18–22 years) | 20,059 | 20.30 | .93 |

*Note:* All measures are updated weekly except education and psychological orientation toward sex and contraceptive use, which are updated every 12 weeks.

### *Psychological Orientation Toward Sex and Contraceptive Use*

Given that self-efficacy and attitudes toward sex and contraception may affect sexual behavior as well as contraceptive use (Barber 2001; England et al. 2016), we control for

all three. Self-efficacy is derived from four questions, asked every three months, with possible values ranging from 0 to 100: "What are the chances you could . . ." (1) "stop your partner from having sex with you?," (2) "get your partner to withdraw or 'pull out' before ejaculating or coming?," (3) "get your partner to use a condom?," and (4) "stop yourself once you were highly aroused or turned on?" We average responses to these questions each time they were asked.

Our measure of attitudes toward sex pertains to casual sex specifically. This measure was assessed every three months with responses to the following statement: "It is alright for young people to have premarital sex even if they are just friends." Answers ranged from 1 (strongly agree) to 5 (strongly disagree). We reverse-code responses so that higher values indicate greater approval of casual sex.

Attitudes toward contraception are based on responses to eight statements, which were also asked at three-month increments: "If a woman asks her partner to use a condom, he will think that she doesn't trust him." "Birth control is morally wrong." "In general, birth control is too much of a hassle to use." "Using birth control is likely to make a woman feel sick." "Using birth control interferes with sexual enjoyment." "If a girl uses birth control, she is looking for sex." "In general, birth control is too expensive to buy." "It takes too much planning ahead of time to have birth control on hand when you're going to have sex." Respondents were asked to express how much they agreed or disagreed with each of these statements, on a scale of 0 to 4, with higher responses indicating greater agreement. We reverse-code each response and sum responses to form a contraceptive opposition scale ranging from 0 to 32, with higher values indicating more opposition.

*Demographic Background*

We control for demographic characteristics that previous research suggests are related to sex and contraceptive use (Bearak 2014; Finer and Zolna 2014; Udry and Billy 1987). These include respondents' education, which was updated every three months (less than high school, high school, and enrolled in or graduated college); and age, which was updated weekly and measured in years (ranging between 18.00 and 22.90).

*Temporal Dimensions*

To account for possible seasonal variation in sex and contraceptive use, we control for month of study.

## Analytic Strategy

This analysis begins with an assessment of our first question, which regards behavioral changes between weeks when respondents were concurrent and weeks when they were not. To answer this question, we estimate regression models with person fixed effects. These models substantially improve upon earlier research by comparing respondents with themselves at other points in time, thus accounting for fixed, unmeasured confounders (Gelman and Hill 2007). Because all outcomes are dichotomous, we estimate these models using logistic regression. When estimating logistic regressions with fixed effects, we necessarily exclude from the model women whose behavior never

changed—for example, women who always or never used contraception.[12] As such, the number of observations varies from model to model, and the coefficients represent within-woman differences between when they had sex with multiple people and when they had sex with one person only.

Then, to address the question of whether contraceptive responses vary by relationship context, we reestimate our fixed-effects models including two-way interaction terms between concurrency and (1) whether a respondent was in an allegedly exclusive relationship, (2) whether a respondent was transitioning between partners, (3) the duration of her current relationship, and (4) the number of prior breakups with her current partner. All four interactions are included in the same model. Testing interactions in separate models yields substantively similar results (available upon request).[13]

To answer our third question about behavioral differences between women who were never- and ever-concurrent, specifically in nonconcurrent weeks, we estimate regression models containing random effects. In this portion of our analysis, the predictor of interest integrates information on whether women were ever concurrent during the RDSL and whether they were concurrent specifically in a given week. In other words, we rely on a three-category measure defined as never concurrent, concurrent but not this week (the reference group), or concurrent this week. Because women whose behavior never changed are retained in models with random effects, these models reveal between-group differences that could lead to disparate sexual health trajectories and also provide a sensitivity test for our fixed-effects analysis. Moreover, because women whose behavior never changed are included in these models, they facilitate a comparison of the magnitude of contraceptive differences between never- and ever-concurrent women (when not concurrent) with the magnitude of contraceptive differences between concurrent and not-concurrent weeks (among ever-concurrent women).

In all three sets of analyses, we conceptualize decision-making about coital contraceptive use as a two-step process in which women first decide whether to use any contraception and, if so, whether to use condoms. This conceptualization is reflected in our modeling strategy: because women's contraceptive use may be motivated by not only wanting to avoid STI transmission but also wanting to avoid pregnancy, we begin by assessing whether women used any form of contraception. Then, to assess condom use specifically, we restrict the analytic sample to weeks in which women used any contraception. Considering that condom and hormonal contraceptive use may be jointly determined and that some women may regularly use hormonal contraception to protect against pregnancy (but not STI transmission), we separately estimate whether women were more likely to use condoms at all and to use condoms when also using a hormonal method. Finally, to investigate contraceptive consistency, we restrict the sample to

[12] For example, 37 % and 59 % of ever- and never-concurrent women (respectively) used some form of contraception every week that they had sex; 2 % and 3 % of ever- and never-concurrent women (respectively) never used any form of contraception in weeks when they had sex; 6 % of ever-concurrent women and 28 % of never-concurrent women used condoms every week that they had sex and used contraception; and 10 % of ever-concurrent women and 15 % of never-concurrent women never used condoms in weeks when they had sex and used contraception.

[13] Because cheating may occur as part of relationship transitioning, we also test a three-way interaction term among concurrency, exclusivity, and transitioning. The coefficients on this interaction term are null, and the interaction is therefore not included in the final models (results not shown).

weeks in which women used condoms and examine whether they reported using condoms every time they had sex that week (separately if they used condoms as their only method and if they used condoms while also taking hormonal contraception). To determine whether women continue to adjust their contraceptive use after concurrency, we include both our contemporaneous measure of concurrency and our one-week lagged measure.

All results are exponentiated to convey changes or differences in odds ratios. Values greater than 1 therefore indicate a positive association, and values less than 1 indicate a negative association. Although we do not present the coefficients on control variables, all models adjust for the full set of relationship characteristics; respondents' sexual and reproductive history, psychological orientation toward sex and contraception, and demographic background, as listed in Table 1; and calendar month.

## Do Women Change Their Contraceptive Behaviors When They Are Concurrent?

Table 2 presents the results of our first fixed-effects analysis in which we examine changes in contraceptive use when women went from having sex with one person to having sex with multiple people in a given week. The results in this table suggest that compared with weeks in which women had one partner, their odds of using any contraception increased 255 % when they were concurrent. Focusing specifically on weeks when women used any contraception, their odds of using condoms were 360 % higher when concurrent. In weeks when women used a hormonal method, their odds of also using condoms increased by 431 % when they were concurrent compared with having sex with just one person in a given week. As evidenced by the null coefficients on lagged concurrency, each of these contraceptive adjustments was short-lived: women adjusted their contraceptive use in the weeks they were concurrent but not in the weeks immediately after.

**Table 2** Effects of concurrency on contraceptive use in a given week, estimated from logistic regressions with person fixed effects

| | | If Used Any Contraception: | If Used a Hormonal Method: | Used a Condom Every Time Had Sex This Week if: | |
|---|---|---|---|---|---|
| | Used Any Contraception | Used a Condom | Also Used a Condom | Only Used Condoms | Used Condoms and Hormonal |
| Concurrent This Week | 3.55*** | 4.60*** | 5.31*** | 0.68 | 0.86 |
| | (0.95) | (0.79) | (1.47) | (0.22) | (0.41) |
| Concurrent Last Week | 1.34 | 1.35 | 1.39 | 1.13 | 1.19 |
| | (0.39) | (0.27) | (0.44) | (0.57) | (0.64) |
| Number of Observations (sexually active weeks) | 11,268 | 12,811 | 6,440 | 1,854 | 1,996 |
| Number of Respondents | 326 | 465 | 257 | 181 | 164 |

*Notes:* All models control for month of year; whether the respondent was in a relationship and with the same primary partner in the preceding week; and her relationship characteristics, sexual and reproductive history, psychological orientation toward sex and contraceptive use, and demographic background (for more details, see Table 1). Robust standard errors are shown in parentheses.

***$p < .001$

Despite substantial increases in women's odds of using condoms in weeks when they were concurrent, they were no more likely to use condoms every time they had sex in a given week when they had sex with multiple people compared with one person (Table 2). Although we cannot be certain with whom women used condoms, if women used condoms with their secondary partner, then in most cases, this precaution should have protected primary relationships from outside infection.

### How Uniform Are Contraceptive Responses Across Relationship Context?

To explore the potentially moderating effect of relationship context, we next reestimate each of our models, including two-way interactions between concurrency and relationship exclusivity, transitioning partners, relationship duration, and number of prior breakups with current partner.[14] In these models, we do not lag concurrency because our analysis in Table 2 provides little evidence that women continued to adjust their contraceptive behavior in following weeks.[15] As shown in Table 3, we do not find statistically significant evidence that women's contraceptive adaptations to concurrency varied across these relationship characteristics.

The results of our fixed-effects analyses together indicate that women increased their contraceptive use, especially their condom use, when they were concurrent. These adjustments did not significantly differ across relationship context. However, contraceptive consistency did not increase with concurrency, and women made contraceptive adjustments only in the same week as when they were concurrent. These latter two findings, when taken together, suggest that the uptick in contraceptive use was likely driven by condom use with secondary rather than primary partners.

### How Do the Contraceptive Behaviors of Never- and Ever-Concurrent Women Differ When Not Concurrent?

Although the preceding analysis suggests that ever-concurrent women made important contraceptive adjustments when they were concurrent, they may still have been more likely to engage in behaviors that could jeopardize their own and their partners' sexual health when not concurrent. The results of random-effects models presented in Table 4 confirm this possibility: women who were never concurrent had 79 % higher odds of using any contraception than ever-concurrent women in weeks when they had sex with only one person. Moreover, in weeks when they had sex and used condoms only, never-concurrent women's odds of using condoms every time they had sex were 91 % higher than ever-concurrent women's.

Our random-effects results also confirm the robustness of our fixed-effects models. That is, the pattern of coefficients on *concurrent this week* mirrors the pattern in Table 2 (in which women whose contraceptive behavior never changed during the study period are necessarily excluded). A comparison of these coefficients to those on *never concurrent* further illuminates that within-woman changes as a function of concurrency

[14] Transitioning partners indicates that a woman reported a distinct primary partner in the immediately preceding or immediately succeeding week (or both). The reference category is that she reported the same primary partner or no partner (or a combination) in those adjacent weeks.

[15] Accordingly, we also do not include indicators of whether the respondent was *in a relationship last week* or had the *same primary partner last week*.

**Table 3** Moderating effects of relationship context on the effects of concurrency on contraceptive use in a given week, estimated from logistic regressions with person fixed effects

| | | If Used Any Contraception: | If Used a Hormonal Method: | Used a Condom Every Time Had Sex This Week if: | |
|---|---|---|---|---|---|
| | Used Any Contraception | Used a Condom | Also Used a Condom | Only Used Condoms | Used Condoms and Hormonal |
| Concurrent This Week | 8.66** | 5.71*** | 5.83** | 1.54 | 1.26 |
| | (6.61) | (2.13) | (3.29) | (1.21) | (1.12) |
| In an Exclusive Relationship | 0.38*** | 0.66*** | 0.57*** | 0.70 | 0.36*** |
| | (0.06) | (0.07) | (0.10) | (0.18) | (0.10) |
| Transitioning Partners | 1.71** | 1.50*** | 1.57* | 1.55 | 1.80 |
| | (0.28) | (0.17) | (0.29) | (0.45) | (0.58) |
| Relationship Duration | 0.98** | 1.00 | 0.99 | 1.01 | 1.01 |
| | (0.01) | (0.00) | (0.01) | (0.01) | (0.01) |
| Number of Prior Breakups With Current Partner | 0.97 | 0.96 | 0.73*** | 0.84 | 0.82 |
| | (0.05) | (0.03) | (0.06) | (0.09) | (0.14) |
| Concurrent × In an Exclusive Relationship | 0.37 | 1.30 | 1.85 | 0.82 | 0.99 |
| | (0.26) | (0.50) | (1.07) | (0.62) | (0.87) |
| Concurrent × Transitioning Partners | 0.54 | 0.48 | 0.30 | 0.44 | 0.75 |
| | (0.33) | (0.18) | (0.20) | (0.33) | (0.70) |
| Concurrent × Relationship Duration | 1.00 | 0.99 | 0.97 | 0.98 | 0.99 |
| | (0.02) | (0.01) | (0.02) | (0.02) | (0.03) |
| Concurrent × Number of Prior Breakups With Current Partner | 0.97 | 1.03 | 1.35 | 0.84 | 0.72 |
| | (0.13) | (0.09) | (0.37) | (0.18) | (0.51) |
| Number of Observations (sexually active weeks) | 11,268 | 12,811 | 6,440 | 1,854 | 1,996 |
| Number of Respondents | 326 | 465 | 257 | 181 | 164 |

*Notes:* All models control for month of year and respondents' relationship characteristics, sexual and reproductive history, psychological orientation toward sex and contraception, and demographic background (for more details, see Table 1). Robust standard errors are shown in parentheses.

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

are substantially larger than between-group differences (between never-concurrent women and ever-concurrent women when not concurrent).

To better visualize patterns of contraceptive use across concurrency, we translate the results of Table 4 into predicted probabilities (expressed as percentages) in Fig. 3. As this figure reveals, when they were not concurrent, ever-concurrent women had a 78 % probability of using any contraception. This is 4 percentage points (or 5 %) lower than the 82 % probability among never-concurrent women and 7 percentage points (or 9 %) lower than their own probability (85 %) when they were concurrent. When using contraception and not concurrent, ever-concurrent women's probability of using condoms was 45 %. This is not significantly different from the 49 % probability among never-concurrent women, but it is 20 percentage points, or nearly one-third, lower than

**Table 4** Effects of concurrency on contraceptive use in a given week, estimated from logistic regressions with random effects

| | | If Used Any Contraception: | If Used a Hormonal Method: | Used a Condom Every Time Had Sex This Week if: | |
|---|---|---|---|---|---|
| | Used Any Contraception | Used a Condom | Also Used a Condom | Only Used Condoms | Used Condoms and Hormonal |
| Concurrency (ref. = concurrent but not this week) | | | | | |
| Never concurrent | 1.79* | 1.45 | 1.53 | 1.91* | 0.82 |
| | (0.49) | (0.37) | (0.56) | (0.54) | (0.28) |
| Concurrent this week | 3.33*** | 5.32*** | 6.49*** | 0.60 | 0.75 |
| | (0.89) | (0.94) | (1.83) | (0.20) | (0.30) |
| Constant | 8.26 | 15.07 | 17.68 | 0.89 | 25.14 |
| | (15.52) | (21.33) | (38.41) | (2.43) | (68.82) |
| Number of Observations (sexually active weeks) | 20,057 | 15,946 | 8,745 | 3,290 | 2,875 |
| Number of Respondents | 758 | 736 | 516 | 482 | 380 |

*Notes:* All models control for month of year; whether the respondent was in a relationship and with the same primary partner in the preceding week; and her relationship characteristics, sexual and reproductive history, psychological orientation toward sex and contraceptive use, and demographic background (for more details, see Table 1). Robust standard errors are shown in parentheses.

*$p < .05$; ***$p < .001$

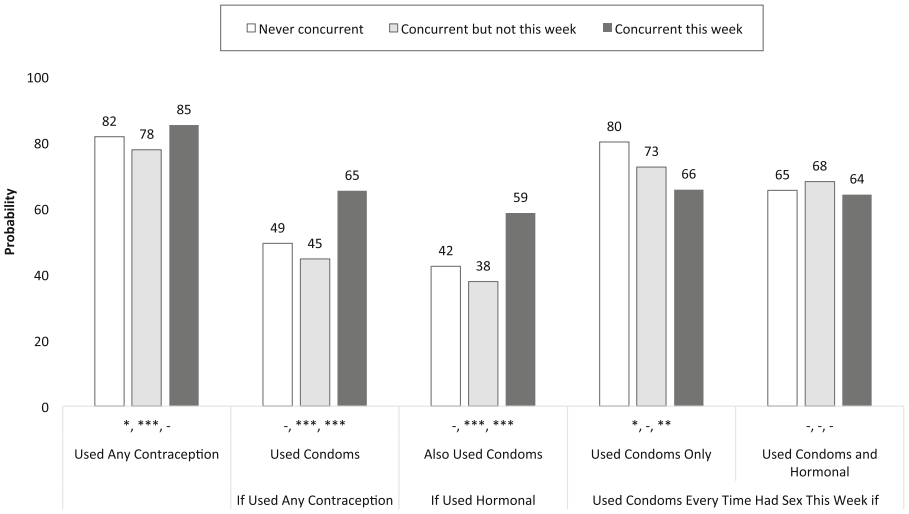


**Fig. 3** Predicted probabilities of contraceptive use. Predicted probabilities are generated from the results presented in Table 4. Asterisks, respectively, indicate differences between (1) concurrent but not this week and never concurrent, (2) concurrent but not this week and concurrent this week, and (3) never concurrent and concurrent this week. *$p < .05$; **$p < .01$; ***$p < .001$

their own probability of condom use in weeks when they had sex with two or more people. A similar pattern is observed with respect to condom use when women also used hormonal contraception. When ever-concurrent women were not concurrent and used condoms as their only method, they had a 73 % probability of using condoms every time they had sex. This is 7 percentage points (or 9 %) smaller than the probability when never-concurrent women used condoms as their only method, but it is not distinguishable from ever-concurrent women's own probability specifically when they were concurrent. However, ever-concurrent women's 66 % probability of using condoms consistently when condoms were their only method is significantly lower, by 14 percentage points (18 %), than never-concurrent women's probability. Women's probability of using condoms consistently when also using a hormonal method ranged between 64 % and 68 % and did not vary with concurrency. In sum, the magnitude of differences between ever- and never-concurrent women's contraceptive use when not concurrent was notably smaller than the magnitude of differences between concurrent and nonconcurrent weeks among concurrent women specifically. Thus, overall, contraceptive and condom use were highest in weeks when women had sex with two or more people, specifically because of the adjustments ever-concurrent women made in these weeks. However, consistency of condom use was lowest among ever-concurrent women when condoms were their only method.

To briefly summarize, in weeks when they were not concurrent, ever-concurrent women's contraceptive use and consistency of condom use were lower than that of never-concurrent women's. Over time, these differences could contribute to disparate sexual health trajectories of young women and their partners. And yet, within-group differences between concurrent and not concurrent weeks among ever-concurrent women were as much as 400 % larger than these cross-group differences. Correspondingly, contraceptive use and condom use were highest in weeks when women had sex with two or more people.

## Sensitivity Analyses

### *Identifiably Embedded Concurrency*

Until this point, we have conceptualized concurrency as having sex with two or more people in the same week. However, because we are sometimes unable to determine when sex with two or more people represents *embedded concurrency* (a situation in which respondents had sex with Partner A, then Partner B, and then Partner A again), we investigate the extent to which respondents' contraceptive responses to concurrency differed between concurrency that was identifiably embedded—that occurred within a spell of three or more weeks with the same primary partner—and concurrency that was not. To do so, we reestimate our fixed-effects models from Table 2 including an interaction term between concurrent and an indicator that the respondent had the same primary sexual partner in the immediately preceding and following weeks. The results, presented in Table A1 (online appendix), indicate that the positive effects of concurrency on contraceptive and condom use are largely consistent across embeddedness, but the effect of concurrency on condom use in general and on condom use if using a hormonal method are even greater in weeks when concurrency is identifiably embedded than in weeks when it is not (Table A1). In other words, these supplemental findings confirm that our operationalization of concurrency as sex with two or more people in one week does not bias our conclusions and suggest not only that women

took extra precautions to offset the risk of STI transmission when concurrent but that they were even more likely to do so when concurrency was identifiably embedded.

*Sexual Activity*

Although differences in condom use between ever- and never-concurrent women are a critical component of STI transmission dynamics, another critical component is differences in sexual activity. That is, if ever-concurrent women have sex with greater regularity than never-concurrent women, this could amplify the risks associated with inconsistent condom use. We therefore investigate whether ever-concurrent women were more likely to have sex in a given week than never-concurrent women. To do so, we include all respondent-weeks ($N$ = 32,720 from 758 women), including weeks without sexual activity, to estimate a random-effects model in which we use a dichotomous indicator of whether a respondent was ever concurrent during the study period to estimate her odds of having sex in a given week, including the same controls as our primary models.[16] The results suggest that ever-concurrent women's odds of having sex in a given week are 51 % higher than never-concurrent women's. In terms of predicted probabilities, this translates into a difference of 7 percentage points, or an 11 % difference (70 % among ever-concurrent women vs. 63 % among never-concurrent women).

Nevertheless, one way that women may mitigate the perceived risks associated with concurrency is to avoid it altogether. In other words, women may have abstained from having sex with their primary partner when they had sex with someone else (and vice versa). Because such abstinence would simultaneously diminish concurrency and condom use, it could bias our effect estimates. To test this, we estimate a logistic regression with person fixed effects examining whether respondents were less likely to have sex with primary partners when they had sex with someone else that week, although the results can be interpreted in either direction because the reverse (e.g., that women abstained from sex with someone else when they had sex with their primary partner) may also have been true. The results (available upon request) provide no indication that women were any less likely to have sex with their primary partner in weeks during or immediately after they had sex with someone else (and vice versa).

## Discussion

For decades, scholars have expressed concerns about asking people to report the first and last dates of intercourse with specific partners—a strategy that suffers from recall bias and that may not capture sexual overlap within a short window of time. In addition, scholarship relying on cross-sectional data has yielded puzzling findings. Although probabilistically, concurrency should not increase the likelihood of STI infection above and beyond having multiple, sequential relationships (all else being equal), numerous studies have found higher rates of STIs among recently concurrent individuals than among individuals who have not recently been concurrent (Javanbakht et al. 2010;

[16] The one exception is that we do not control for number of prior weeks she has had sex with her current partner.

Manhart et al. 2002; Mishra and Bignami-Van Assche 2009; Rosenberg et al. 1999; Washington et al. 2018). These prior studies' findings suggest that concurrency is likely a proxy for a broader set of risk-taking behaviors that undermine sexual health. Our findings, based on repeated observations of young women's sexual and contraceptive behaviors for up to 2.5 years, affirm this possibility. That is, in weeks when ever-concurrent women had concurrent sexual partners, they tripled their odds of using any contraception and quadrupled their odds of using condoms. This pattern held uniformly across four key relationship characteristics: exclusivity, transitioning, duration, and instability, although a sensitivity test suggests that some contraceptive adjustments were larger when concurrency was embedded within multiple weeks with the same primary partner than when it was not. Nevertheless, in weeks when they were not concurrent, ever-concurrent women were less likely to use any contraception and used condoms less consistently than never-concurrent women.

The juxtaposition between ever-concurrent women's overarching pattern of riskier behavior and the contraceptive adjustments they make specifically when concurrent have important theoretical implications. The extra precautions women take when they are concurrent are just that—*extra*. In other words, they do not extend the same precaution to every sexual encounter. These contraceptive adjustments mean that if people who are concurrent have higher rates of STIs (as others suggest), then their STI acquisition is more likely to occur when they are not concurrent than when they are because their contraceptive use and consistency of condom use are lower in nonconcurrent weeks. Lower rates of contraceptive use and consistency in nonconcurrent weeks may arise if young women erroneously trust their partners while not concurrent or believe that having unprotected sex with only one person in a given week poses low risks (at least lower than unprotected sex with multiple people).

However, sexual health may also be compromised by drug and alcohol use because these substances impair judgment; moreover, intravenous drug use can lead to the exchange of bodily fluids. Indeed, several studies have suggested behavioral overlap between substance use and concurrency (Adimora et al. 2011; Riehman et al. 2006). Although we are unable to explore substance use with the RDSL, our findings suggest that sexual health disparities attributable to differences in substance use should largely be *in addition to*, rather than *in place of*, differences in sexual behavior and contraceptive use.

Demographers and public health scholars interested in how sexual health disparities take shape should give more careful consideration to the role of selection. Most cross-sectional studies of concurrency have been unable to describe individuals' sexual behaviors occurring just before or just after concurrency and were even less able to situate concurrency within a broader pattern of behavior. Even if data limitations prevent scholars from empirically testing the role of selection, our findings suggest that it is a mistake to assume that these differences are trivial. Exaggerating the role of concurrency in STI transmission dynamics and overlooking co-occurring behaviors that also elevate the risk of transmission oversimplify the relationship between concurrency and sexual health.

Despite its unique contributions, this study is not without limitations. The first is conceptual: we are able to determine whether women had sex with multiple people in a given week, but we do not know the specific days they had sex with each person. However, a sensitivity test examining variation in the effects of concurrency

conditional on whether it was identifiably embedded leads to substantively similar conclusions. Moreover, the results of this test indicate that the effects of concurrency on condom use in general and on condom use when also using a hormonal method are both greatest in identifiably embedded weeks. This finding is consistent with extant research, which suggests that condom use more often occurs with secondary rather than primary partners (Lichtenstein et al. 2008; Macaluso et al. 2000; Senn et al. 2009), likely because it is intended to protect ongoing primary relationships from outside infection (Gorbach et al. 2002). We could not distinguish between condom use with primary and secondary partners in this analysis, however, because the RDSL did not identify with whom respondents used condoms. Given that the consistency of condom use did not improve with concurrency, we cannot be entirely sure that condom use occurred with secondary partners. That contraceptive adjustments did not endure beyond the week of concurrency and increases in condom use were greatest in embedded concurrent weeks nevertheless suggests that for most concurrent women, the uptick in condom use primarily occurred with outside partners.

A second limitation is that we do not have verifiable information on respondents' STI status. We therefore cannot assess whether or how this status varies with concurrency across or within women over time.

A third limitation is that our measure of concurrency is limited to heterosexual vaginal intercourse. The omission of nonheterosexual intercourse should not influence the pattern of contraceptive adjustments we observe. However, our emphasis on vaginal intercourse precludes us from understanding whether and how women substitute other sexual behaviors, such as anal and oral sex, for vaginal intercourse when they are concurrent. It also prevents us from determining whether women change their condom use in response to concurrency that includes anal and oral sex but not vaginal sex.

A final set of limitations pertains to the nature of the RDSL sample, which is composed of young adult women from one county in Michigan. This narrow geographic focus means that our study lacks the external validity needed to make inferences about young women in the United States as a whole, despite that our sample looks and behaves much like young women of the same age throughout the country (Clark 2018; Lesthaeghe and Neidert 2006). It also prevents us from making inferences about concurrency in culturally and institutionally distinct settings, such as in sub-Saharan Africa, where much of the debate about concurrency's role in the HIV epidemic has taken place. Moreover, young women do not always possess the sexual agency needed to negotiate condom use with partners (Crosby et al. 2008; Gorbach and Holmes 2003). This means that the estimated effects of concurrency do not necessarily represent how much young women want to use condoms when concurrent. Furthermore, relying on a sample of young women means that we are unable to make direct inferences about older adults or about men. This leaves open important questions for future research about whether young men, like young women, perceive and account for the risks associated with concurrency and/or whether the broader sexual comportment of ever-concurrent men differs from that of never-concurrent men.

Concurrency is often conceptualized as a risky behavior because it can theoretically increase the rate of STI transmission if unaccompanied by condom use. Our findings, however, indicate that women make temporary contraceptive adjustments to offset the risk of transmission specifically when they are concurrent but that

otherwise, women who are concurrent tend to use contraception less often and use condoms less consistently than women who are not concurrent. These findings point to the importance of distinguishing between concurrency as a behavior and as a characteristic of individuals' sexual history when conceptualizing the role of concurrency in STI transmission dynamics.

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