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Sexual activity and weekly contraceptive use among young adult women in Michigan

Susannah E. Gibbs, PhD MSPH [Postdoctoral Research Associate] [PhD Candidate],

College of Public Health and Human Sciences, Oregon State University

Department of Population, Family and Reproductive Health, Johns Hopkins Bloomberg School of Public Health

Yasamin Kusunoki, PhD MPH [Assistant Professor],

School of Nursing, Department of Systems, Populations and Leadership, Institute for Social Research, Population Studies Center and Survey Research Center, University of Michigan

Elizabeth Colantuoni, PhD ScM [Associate Scientist],

Department of Biostatistics, Johns Hopkins Bloomberg School of Public Health

Caroline Moreau, MD PhD MPH [Associate Professor]

Department of Population, Family and Reproductive Health, Johns Hopkins Bloomberg School of Public Health

Abstract

Past studies on the influence of sexual activity on contraceptive behaviours are inconclusive, relying heavily on cross-sectional data sources. We used a population-based longitudinal sample of young women in a Michigan county to evaluate weekly associations between sexual activity and contraceptive use. We used multinomial logistic regression accounting for correlations within partnerships and women, assessing effects of woman-level, partnership-level, and week-level sexual activity on contraceptive use. Relative to use of least effective methods, weekly sexual activity was associated with condom (aRRR:2.00;95% CI:1.73–2.31), pill (aRRR:2.00;95% CI:1.71–2.32), and highly effective method use (aRRR:2.49;95% CI:1.90–3.82). For non-barrier methods, partnership-level and woman-level effects were similar to week-level effects. For condoms, there was no significant woman-level effect. Evidence of immediate effects of sexual activity on contraceptive use within a single week highlights the importance of longitudinal data. These dynamics may be diluted or missed altogether when relying on cross-sectional data approaches that compare groups of individuals.

Keywords

Contraceptive use; sexual activity

Background

Young adults in the United States are the demographic that experiences the highest unintended pregnancy rates and the greatest share of unintended births. One in three unintended births in the United States is to a woman aged 20–24 (Mosher et al. 2012), and the unintended pregnancy rate of 104 pregnancies per 1,000 women in this age group is almost two times the rate among adolescents (Finer and Zolna 2014). Almost nine out of ten women ages 20–24 who are at risk of an unintended pregnancy are current contraceptive users (Mosher et al. 2016). About 40% of unintended births, however, are conceived while women are using contraception (Mosher et al. 2012), in part reflecting inconsistent use and use of less effective methods (Trussell 2011). Understanding when and why young women use specific contraceptive methods can help inform strategies to improve reproductive autonomy in this age group and prevent unintended pregnancies.

Sporadic patterns of sexual activity, not uncommon in this stage of the life course, may be an important factor that influences contraceptive use. This dynamic, however, has not been thoroughly examined in the research literature. Infrequent sexual activity is one of the main reasons that women who are at risk of unintended pregnancy cite for not using contraception (Frost et al. 2007b; Mosher et al. 2012). While the association between more frequent sexual activity and increased use of any contraceptive method has been substantiated in national cross-sectional surveys (Frost et al. 2007a; Wu et al. 2008), not all studies have consistently found this association (Wilson and Koo, 2008). Several studies that have assessed use of specific types of contraceptive methods have also found that more frequent sexual activity is associated with use of more effective methods (Frost and Darroch 2008; Kusunoki and Upchurch 2011; Wildsmith et al. 2015), though here too, not all studies find a significant association (Wilson and Koo 2008). Interpretation and comparison of these studies can be difficult, as the measures vary widely, particularly with respect to the amount of time over which measures of sexual activity and contraceptive use are summarised. Measures used in prior research often summarise behaviours over the course of many months rather than assessing short-term associations over days or weeks, a timeframe in which women likely make short-term and medium-term contraceptive decisions.

Inconsistent findings in the literature also reflect the limitations of using cross-sectional data sources to study associations between patterns of sexual activity and contraceptive use. For behaviours that change over time, analyses of cross-sectional data rely on the assumption that comparisons at a single point in time between individuals with different behaviours will approximate, on average, the associations for individuals as their behaviours vary over time. This assumption may not be accurate for sexual activity and contraceptive behaviours. A longitudinal study of sexual health risk behaviours found that across multiple sexual health outcomes, including sex with a high risk partner, partner risk communication, alcohol use before sex, and condom use, there was substantially more variance in these outcomes within individuals over time than between individuals (Cooper 2010). Prior research also suggests that an individual's contraceptive behaviour with one partner may influence contraceptive practices with a subsequent partner (Lantos et al. 2016). This preliminary evidence suggests that the variation in sexual activity and contraceptive behaviours within individuals over time may be substantial and not adequately captured in cross-sectional data sources.

The first objective of this study is to examine weekly associations between sexual activity and those contraceptive behaviours. According to multiple theories of health behaviour, perceived risk or perceived susceptibility to a health outcome is important in shaping health behaviours (Brewer and Rimer 2008). A woman may therefore adjust her contraceptive behaviour according to her level of sexual activity because of a change in perceived risk of unintended pregnancy, an association that has been theorized and substantiated in prior research (DuRant, Jay et al. 1990). Thus, our first hypothesis is that increased weekly sexual activity will be associated with use of more effective and longer acting methods.

The second objective of this study is to compare the associations between contraceptive use and sexual activity across different levels of measurement. Specifically, we will compare the associations between (i) week-level sexual activity and immediate contraceptive use; (ii) partnership-level sexual activity and contraceptive use across all weeks in a partnership; and (iii) women-level sexual activity and contraceptive use across all partnerships. The independent effect at each of these three levels will be assessed to identify the extent to which the approach taken in cross-sectional research (woman-level associations) reflects the shorter-term associations that occur over time for individual women (week-level associations), while also taking into account variation in behaviours between partnerships (partner-level associations). Our second hypothesis is that as the data are summarised across longer timeframes effect sizes will be attenuated, with the greatest amount of information in week-level associations and the least information in woman-level associations.

Methods

Sample

Data for these secondary analyses come from the Relationship Dynamics and Social Life (RDSL) study, a longitudinal study with the broad goal of assessing the dynamics of unintended pregnancy through frequent measurement of pregnancy intentions, contraceptive use, and relationship characteristics (Barber et al. 2015). The population-based sample of women ages 18–19 at baseline was randomly selected from a racially and socioeconomically diverse county in Michigan. Women were sampled using the Michigan Department of State driver's license and Personal Identification Card database. This sampling frame was compared to census population projections, which indicated a 96% agreement (Barber et al. 2011). The initial baseline survey was completed in 2008 and 2009 through an interviewer-administered in-person survey with 1,003 participants and achieved an 83% response rate. The baseline survey lasted approximately one hour and assessed participant sociodemographic characteristics, relationship experiences, and sexual and reproductive history.

Of the initial baseline sample, 95% of women participated in weekly follow-up surveys administered over the phone or online over the course of the subsequent two and a half years. Participants were compensated with \$1 per weekly journal completed, and with \$5 bonuses for completion of five consecutive journals. High retention rates were achieved at six months (84%), one year (79%) and 18 months of follow up (75%). Participants were asked weekly about sexual activity, pregnancy intentions, contraceptive use, and pregnancy, with other questions asked only when applicable. Additional detail about the implementation

of the study has been published elsewhere (Barber et al. 2011). The original study received ethical approval from the University of Michigan Institutional Review Board and by the National Institutes of Health. The Johns Hopkins Bloomberg School of Public Health Institutional Review Board exempted these secondary analyses from full review.

We conducted analyses of contraceptive method use for women ever sexually active in weeks where they were with a partner, were not pregnant, and indicated clearly not wanting to become pregnant. Weeks with a partner were identified if women said they were still with the partner mentioned in the prior survey or indicated that they had “a special romantic relationship with anyone” or “physical or emotional contact, such as kissing, dating, spending time together, sex, or other activities with a partner.” Weeks were excluded if no partner was reported (n=22,078), pregnancy was reported (n=2,602), pregnancy intentions were not strongly anticonception (n=2,987) or were missing (n=812), and if they were sexually inactive weeks prior to first report of sexual activity during the study (n=5,593). The analytic sample included a total of 737 women and 24,533 weeks. Weeks with missing data on sexual activity or contraceptive use (n=69) were excluded from the analysis. There were no missing data for potential confounders except for partner fertility desires, which were missing in 0.2% of weeks (40/24,533). Missing data were not imputed due to the very low frequency of missingness.

Exposure variables

Each week, women were asked whether they had vaginal sexual intercourse in the prior week. The primary exposure for this analysis is a dichotomous measure of weekly sexual activity. We also calculated a summary measure of partnership-level sexual activity, defined as the proportion of weeks sexually active among all weeks in a specific partnership. Finally, we calculated a measure of woman-level sexual activity, the proportion of weeks sexually active among all weeks in which women had a partner during the study. To estimate independent effects of sexual activity on specific method use at each level (week, partnership, and woman), we centred weekly sexual activity on each partnership's overall proportion of sexually active weeks, and each partnership's proportion of sexually active weeks on women's overall proportion of sexually active weeks. Including these summary measures of sexual activity in models permits assessment of the effect of weekly sexual activity on contraceptive use independently of the effect of the overall level of sexual activity within a partnership and for an individual woman. This analytic approach is described in greater detail as part of our statistical methods. This approach has been detailed in the statistical literature (Begg and Parides 2003), and has been applied to other longitudinal analyses of other sexual health behaviours (Weir and Latkin 2015; Harvey et al. 2016).

Outcome variable

Contraceptive use was ascertained every week by asking women if they used anything to prevent pregnancy. Those who answered affirmatively were then asked sequentially about specific non-coital methods prior to asking about sexual activity and coital methods. In weeks when women reported sexual activity, they were asked whether they had used a condom that week. Information about condom use was carried forward to sexually inactive weeks that followed sexually active weeks of condom use if no other method was reported

during these sexually inactive weeks ($n=2,449$ weeks). This approach identifies “current” contraceptive use for coital methods, analogous to how current contraceptive use would be identified in a cross-sectional survey. Methods were grouped according to effectiveness (Trussell 2011), and weeks were classified into four categories according to the most effective method used that week: (i) least effective methods, such as withdrawal, or no method (referred to as least effective methods); (ii) condoms; (iii) pill, patch, and ring (referred to as pill); and (iv) highly effective methods, including the injectable, IUD, implant, and male and female sterilisation. For the purpose of descriptive statistics, we also summarized contraceptive use at the partnership and woman levels, calculating the percentage of analytic study weeks during which women reported using each type of method overall and within each partnership.

Potential Confounding Variables

We considered a series of potential confounders that we included in adjusted models as indicated. Potential sociodemographic confounders were assessed at baseline and included age, race/ethnicity, high school GPA, post-secondary school enrolment, receipt of public assistance and religiosity. Potential sexual and reproductive health history confounders were also assessed at baseline and included first sex by age 15, multiple sexual partners prior to enrolment, and any pregnancies prior to enrolment.

Partnership qualities and partner sociodemographic characteristics were also assessed for potential confounding. Relationships were typified using a time-varying variable according to seriousness and time intensity into six categories: casual, nonexclusive dating, long distance, exclusive dating, cohabiting, and married or engaged (Kusunoki 2014). We used a time-varying measure of whether the relationship had a prior breakup and reconciliation over the course of the study to assess relationship stability. We considered a time-varying measure of total relationship duration with a specific partner. For partnerships that were ongoing at the start of the study, women were asked when they began this relationship in order to calculate duration. We also included a time-varying measure of whether a participant ever had a pregnancy with her current partner. Characteristics of partners included partner age difference where a partner was three or more years older than a participant, education differential in which a partner was reported to have more education than the participant, and whether a partner had children from a previous relationship. Finally, we constructed a weekly measure of whether perceived partner fertility desires were strongly anti-conception or not. This measure was based on women’s responses to two Likert-style questions with six response options: “How much do you think your partner wants you to get pregnant during the next month?” and “How much do you think your partner wants you to avoid getting pregnant during the next month?” Perceived partner fertility desires were coded as strongly anti-conception if the participant responded either of the two lowest response options for wanting a pregnancy and either of the two highest response options for wanting to avoid a pregnancy.

Statistical Methods

We calculated descriptive statistics at the woman level for individual-level characteristics and at the week level for partnership-level characteristics. The outcome and exposure

variables were summarised at the woman level, partnership level, and week level. For contraceptive outcomes at the woman and partnership levels we calculated the mean percentage of weeks that each contraceptive method was used across women and partnerships respectively, with standard deviations expressed in percentage points.

To decide whether to include candidate confounders in adjusted models, we first examined the association between each confounder with weekly measures of sexual activity and contraceptive use. As needed, we then considered associations between confounders and partnership-level and woman-level measures of sexual activity. Woman-level candidate confounders that were associated with woman-level measures of sexual activity were included in adjusted models, as were candidate confounders associated with partnership-level or week-level sexual activity. A priori, we included women's age as an important confounder based on the available research (Westoff 1974; Call et al. 1995; Frost et al 2007a; Wu et al., 2008; Kornrich et al. 2012). The final set of confounders that were included in adjusted models includes race/ethnicity, age, HS GPA, post-secondary enrolment, religiosity, receipt of public assistance, sex at or before age 15, prior pregnancies, multiple prior sex partners at enrolment, relationship type, relationship duration, prior pregnancies with current partner, partner age and education differences, and partner's pregnancy intentions. Relationship duration was modelled as a linear spline with knot at one year in all models to allow different associations during and after the first year of the relationship. Multicollinearity of the adjusted model was assessed by estimating variance inflation factors (VIFs), which averaged 1.54 for all covariates.

To estimate associations with specific contraceptive method use, we fit multinomial logistic regression models with robust standard errors to account for the clustering of weekly data. To account for clustering of partnerships within women and of weeks within partnerships, we estimated parameter confidence intervals using bootstrapped models with clustered resampling at the level of women in the sample. We preserved all partnerships and weeks for individual women during resampling and estimated each model with 1,000 bootstrap replications. Bias corrected and accelerated (BCa) confidence intervals were estimated for each model. This approach of bootstrapping and estimating the BCa confidence intervals provides more accurate estimates of the standard errors of the regression coefficients and corrects the variance for the correlation among weeks within partnerships and partnerships within women (Carpenter and Bithell 2000).

To estimate independent effects of sexual activity on contraceptive use, we centered weekly sexual activity on each partnership's overall proportion of sexually active weeks, and each partnership's proportion of sexually active weeks on women's overall proportion of sexually active weeks. These centered variables are calculated by subtracting, for example, the overall proportion of weeks sexually active in a specific partnership from the dichotomous measure of weekly sexual activity, or by subtracting the woman-level proportion of weeks sexually active from the partnership-level proportion of weeks sexually active:

$$\text{Log} \left(\frac{\Pr[Y_{ijk} = k]}{\Pr[Y_{ijk} = K]} \right) = \beta_0 + \beta_1(x_{ijk} - \bar{x}_{ij\cdot}) + \beta_2(\bar{x}_{ij\cdot} - \bar{x}_{i\cdot\cdot}) + \beta_3(\bar{x}_{i\cdot\cdot}) + \beta_4 \text{confounders}$$

In this multinomial logistic regression equation, the log of the relative risk ratio for use of method k (e.g. condoms, pills, or highly effective methods) relative to the comparison method K (e.g. least effective methods) is modeled for woman i in partnership j and in week k . In this equation x_{ijk} is the dichotomous weekly sexual activity variable for woman i in partnership j and in week k and $x_{ijk} - \overline{x_{ij.}}$ is the weekly measure of sexual activity centered on the partnership-level measure of sexual activity $\overline{x_{ij.}}$. The partnership-level measure of sexual activity centered on woman-level sexual activity is $\overline{x_{ij.}} - \overline{x_{i..}}$ where $\overline{x_{i..}}$ is the measure of overall woman-level proportion of weeks sexually active.

For the model results reported in tables, partnership-level and woman-level sexual activity measures were scaled by a factor of ten, so that estimates reflect the effect of a ten percentage point increase in the proportion of weeks sexually active at each level. Models were also estimated with unscaled measures of partnership-level and woman-level sexual activity. Using results from these unscaled models we compared woman-level effects and partnership-level effects to the week-level effects using postestimation Wald tests. All analyses were conducted using StataMP 14.2.

Results

Sample description

The 737 women in the sample contributed an average of 33 weeks of data for this analysis (SD=32; range: 1–145). Women reported data on a total of 2,004 partners with an average of 2.7 partners per woman (SD=2.6; range: 1–20); a total of 54% of women contributed data on multiple partners. Each partnership contributed an average of twelve weeks of data (SD=22; range: 1–145).

The sample was socially and demographically diverse (Table 1). Race and ethnicity varied across participants, with 59% white, 30% black, 9% Hispanic, and 2% identifying with other race/ethnic identities. Mean high school grade point average (GPA) was 3.1 (SD=0.62) and 55% were enrolled in post-secondary education at baseline. Just over half of participants (56%) identified as highly religious and 28% had ever received public assistance. About one in three participants (35%) reported having sex by age 15 and 28% had ever been pregnant. Two thirds of participants (68%) reported more than one sexual partner prior to enrolment.

Weekly partnership characteristics provide insight into young women's relationships in this sample (Table 2). One third of weeks were spent in exclusive dating relationships. About one in five weeks were spent in cohabiting (18%), long distance (18%) and married or engaged (17%) relationships respectively. A smaller percentage of weeks were spent in casual (8%) and nonexclusive dating (6%) relationships. One in five weeks were spent in relationships that had dissolved and subsequently reformed, and 17% of weeks were spent in relationships where the participant had reported a pregnancy with the current partner. About one in four weeks were spent with a partner who was at least three years older and only 13% of weeks were spent with a partner who was more highly educated than the participant. Fewer than one in ten weeks were spent with a partner who already had children from a previous

relationship. Participants reported that their partners had fertility desires that were not entirely anticonception in only 6% of weeks.

Overall use of specific contraceptive methods varied between women, and individual women also changed their contraceptive behaviours over time (Table 3). At the week level, the most frequently used method was the pill, which accounted for a total of 42% of weeks of the study, followed by condoms (25%) and least effective methods (26%) (Table 3). At the partnership level, the distribution of methods used was similar to the week level, although condoms were used for a greater percentage of weeks and pills were used less frequently on average. Average woman-level method use was similar to partnership-level method use, with a slightly higher average percentage of weeks of highly effective methods. At the woman level, pills were used for an average of 33% (SD=38%) of each woman's total weeks in the analytic sample. Condoms were the next most prevalent method used, accounting for an average of 30% (SD=34%) of weeks, closely followed by the least effective methods, which accounted for an average of 29% (SD=32%) of women's weeks (this category included both no method, which accounted for an average of 12% (SD=22%) of weeks and less effective methods, which were used for an average of 17% (SD=26%) of weeks). Highly effective methods were least frequently used, on average accounting for only 9% (SD=22%) of women's weeks (this category included the injectable, which was used for an average of 5% (SD=17%) of weeks and all other highly effective methods that were used for an average of 3% (SD=15%) of weeks).

Sexual activity varied both between women and for individual women over time. The proportion of partnered weeks that were sexually active for each woman ranged from 3% to 100%, with an average of 69% (SD=27%) of weeks sexually active (Table 3). At the partnership level, 60% (SD=39%) of weeks were sexually active on average within a partnership. Overall, 65% of weeks in the study were sexually active.

Effect of weekly sexual activity

Weekly sexually activity was associated with use of more effective methods in that same week (Table 4). Sexual activity in a given week was associated with an 83% increased chance of being a condom user in that week compared to being a user of a least effective method (RRR=1.83, 95% CI: 1.64–2.10). This effect was similar for pill use relative to use of the least effective methods (RRR=1.86, 95% CI: 1.66–2.13). For use of highly effective methods, the effect of weekly sexual activity was even greater, with a more than two-fold increase in the chance of highly effective method use relative to use of the least effective methods in sexually active weeks compared to sexually inactive weeks (RRR=2.17, 95% CI: 1.74–3.51).

Comparing between use of the more effective methods—condoms, pill, and highly effective methods—relative to each other there were no significant associations with weekly sexual activity ($p=0.51$). For example, the chance of pill use relative to condom use was similar in sexually active weeks compared to sexually inactive weeks (RRR=1.01, 95% CI: 0.92–1.12). There was also no significant effect of weekly sexual activity on use of the highly effective methods relative to pills (RRR=1.17, 95% CI: 0.88–1.55).

Effect of partnership-level sexual activity

Similar to findings at the week level, at the partnership level, use of each specific more effective method was greater relative to the least effective methods as the proportion of sexually active weeks within a partnership increased. Specifically, for each ten percentage point increase in the proportion of sexually active weeks within a specific partnership, there was a corresponding 5% increase in the chance of condom use relative to use of least effective methods (RRR=1.05, 95% CI: 1.01–1.11). For this same increase in partnership-level sexual activity there was a 9% increased chance of pill use (RRR=1.09, 95% CI: 1.04–1.14) and 10% increased chance of highly effective method use (RRR=1.10, 95% CI: 1.02–1.18), each relative to least effective method use.

Relative use between the more effective methods did not relate to partnership-level sexual activity ($p=0.18$). For example, we found no statistically significant effect of partnership-level sexual activity on use of pills relative to condoms (RRR=1.04, 95% CI: 1.00–1.08) nor on use of highly effective methods relative to pills (RRR=1.00, 95% CI: 0.92–1.12).

Effect of woman-level sexual activity

The effects of woman-level sexual activity on specific method use were largely similar to week-level effects, except for condom use. A ten percentage point increase in the proportion of weeks that a woman was sexually active was associated with an overall 8% decrease in her chance of using condoms relative to using the least effective methods (RRR=0.92, 95% CI: 0.86–0.99). The effect of woman-level sexual activity on pill use relative to the least effective methods was similar to the partnership-level positive effect, but attenuated and not statistically significant (RRR=1.07, 95% CI: 0.98–1.15). The woman-level effect of sexual activity on use of highly effective methods relative to the least effective methods paralleled the effects at the other levels, with a 21% increase in the chance of highly effective method use relative to the least effective methods per ten percentage point increase in a woman's proportion of weeks sexually active (RRR=1.21, 95% CI: 1.06–1.36).

In contrast to the week-level and partnership-level effects, there were significant effects of woman-level sexual activity on relative use of various more effective methods ($p<0.001$). Specifically, each ten percentage point increase in a woman's overall proportion of weeks sexually active was associated with a 16% increased chance of using the pill relative to using condoms (RRR=1.16, 95% CI: 1.07–1.25) and a 31% increased chance of using a highly effective method relative to using condoms (RRR=1.31, 95% CI: 1.16–1.48). There was no significant effect of woman-level sexual activity on use of highly effective methods relative to the pill (RRR=1.13, 95% CI: 1.00–1.28), although this effect approached statistical significance.

Comparison of effects across levels

Comparisons among the week-level, partnership-level, and woman-level effects indicate no significant differences between the magnitude of these effects for pill use relative to the least effective methods ($p=0.54$) or for highly effective methods relative to the least effective methods ($p=0.22$). These results suggest that the average between-women effects provide an accurate approximation of the week-to-week effects for these methods. Comparisons of the

effects on condom use at the three levels, however, indicate significant differences among the effect sizes ($p < 0.001$). Specifically, there was a significant negative effect at the woman level and significant positive effects at week and partnership levels.

Adjusted model

Adjusting for individual-level and partnership-level confounders resulted in some changes to the effects of sexual activity at the woman level, but not at the week level or partnership level (Table 5). Across all effective methods, at the week level the effect of sexual activity on method use relative to the least effective methods remained positive and statistically significant. So too, at the partnership level, effects of sexual activity on specific method use were virtually unchanged. At the woman level, however, there were changes in the effect of sexual activity on condom use and pill use relative to use of the least effective methods. Specifically, the effect of woman-level sexual activity on condom use relative to the least effective methods was attenuated and no longer statistically significant (aRRR=0.98, 95% CI: 0.91–1.06). The effect of woman-level sexual activity on pill use relative to the least effective methods was strengthened, and became statistically significant (aRRR=1.12, 95% CI: 1.03–1.21).

Discussion

Our analyses provide evidence that sexual activity is associated with use of effective contraceptive methods. For hormonal and highly effective methods, our findings are clear and consistent. The positive and significant woman-level effects that we find between sexual activity and use of the pill and highly effective methods support our first hypothesis, that women may alter their contraceptive behaviours in response to changes in perceived pregnancy risk as a function of increased sexual activity. These findings are also consistent with prior cross-sectional literature demonstrating a positive association between sexual activity and contraceptive use (Frost and Darroch 2008; Kusunoki and Upchurch 2011).

We find no significant differences in the magnitude of the effects of sexual activity on relative use of these more effective methods at the week level, partnership level, and woman level. Thus, contrary to our second hypothesis, cross-sectional analyses of summary measures for these more effective methods appear to approximate the more granular dynamic of the associations for individual women over time. Cross-sectional data may therefore have been adequate for these analyses. The attenuation of the effect on pill use at the woman level, however, suggests a decline in analytic power when the data are summarised at the higher order level and highlights the utility of panel data even in cases where summary measures accurately reflect longitudinal dynamics.

The dynamics of sexual activity and condom use appear to be more complex. We found that the expected positive immediate week-level association between sexual activity and condom use was not reflected in an analogous woman-level effect. While the immediate week-level effect indicated increased probability of using condoms relative to using less effective methods or no method during sexually active weeks, on average women who were more sexually active were actually less likely to use condoms relative to a least effective method in unadjusted models. This finding is consistent with prior studies that have specifically

identified associations between less frequent sexual activity and increased condom use including a 1999 meta-analysis (Sheeran et al. 1999), as well as several more recent individual studies (Katz et al. 2000; Sayegh et al. 2006; Marshall et al. 2016). In our adjusted models this between-women effect was attenuated, possibly reflecting confounding by factors that change over the course of relationships. These heterogeneous findings for condom use across levels provide strong support for our second hypothesis, underscoring the importance of repeated short-term measures when designing research studies to understand time-varying influences on condom use rather than relying on summary measures.

Overall, the qualitatively different results for condom use at the week level and partnership level compared to the woman level suggest that sexual activity may influence method use decisions differently for condom use than for use of more effective non-coital methods. Specifically, the condom use results may reflect that women factor only very recent sexual experiences into their decision-making about coital methods, without taking into account more distant past and expected future sexual activity. One important implication of these findings is that cross-sectional studies summarising measures of sexual activity and condom use over time may not adequately reflect the short-term dynamics of these behaviours. A second key implication of the difference in results for condom use relative to pill and highly effective methods is that grouping condoms together with these other methods for analysis of effective contraceptive method use may not be an appropriate analytic strategy for certain influences on contraceptive behaviours as effects may be heterogeneous across specific method type. In these cases, variation between study populations in method mix can result in inconsistent findings between studies. In fact, our findings may explain in part why prior studies have resulted in conflicting results (Frost et al. 2007a; Wilson and Koo 2008; Wu et al. 2008; Wildsmith et al. 2015).

Our primary findings were not substantially confounded by individual and partnership characteristics or by partnership-level effects. Immediate week-level and partnership-level effects of sexual activity on contraceptive method use increase somewhat in magnitude after adjusting for potential confounders, an indicator of conservative confounding. This finding is not unexpected, as many of the potential confounders that are related to decreased contraceptive method use may also be related to increased sexual activity, thus making it unlikely that the positive association between sexual activity and contraceptive use is largely due to confounding.

The focus of our study and of the overall RDSL study is on fertility and the prevention of unintended pregnancy and as such our analysis does not fully account for STI and HIV risk perceptions and preventive behaviours. Our analysis of the influence of sexual activity on condom behaviours is potentially susceptible to this omission, as condoms are highly effective for STI prevention but only moderately effective for pregnancy prevention compared to other contraceptive methods (Sundaram et al. 2017). Furthermore, there is evidence to suggest that dual method use (versus use of condoms only or hormonal methods only) depends on the salience of STI risk perceptions relative to pregnancy risk perceptions (Ott et al. 2002). We categorise weeks in which multiple methods were reported according to the method used that is most effective at preventing pregnancy. Thus, weeks in which condoms were used in addition to a more effective method were classified as pill or highly

effective method weeks. Through an STI prevention lens, the condom use element of these dual use weeks is important, and potentially influenced by patterns of sexual activity. While the RDSL contains data on all methods used in a given week, expanding our outcome measures to include additional dual use categories would have increased the complexity of our study to the detriment of power of the analyses.

As this study was a secondary data analysis, the RDSL was not designed to address our specific research question and we were limited to the available measures. The weekly questionnaire did not include information specifically about coital frequency within a given week and women were not asked about contraceptive use with respect to specific coital events. Furthermore, women were not asked about menstruation, which could affect both sexual activity as well as contraceptive use due to perceptions about susceptibility to pregnancy. The brevity of the weekly journal instrument, however, was critical in ensuring the unusually high retention rate of a study that asked participants to complete weekly surveys for more than two years (Barber et al. 2011). Thus, additional measures in the weekly instrument would likely have added to the burden of response and increased loss to follow-up.

The population from which our sample was drawn is specific such that our quantitative findings may not be generalizable to other populations. Our study focuses on young women ages 18–22 specifically because these are the women most at risk of unintended pregnancy in the United States (Finer and Zolna 2014), and the majority are unmarried and non-cohabitating. The dynamics of sexual activity and contraceptive use, however, may differ among older women and particularly among those who are in longer-term, stable relationships. While additional research may be needed to generalise specific findings to broader populations, our analyses provide implications for the general importance of longitudinal research for sexual and reproductive health behaviours.

Regardless of these limitations, there are several important conclusions from our research that have direct implications for the prevention of unintended pregnancy and the promotion of reproductive autonomy in public health research and practice. The immediate effect of sexual activity on contraceptive use poses a particular challenge to health educators, clinicians, and others providing contraceptive counselling and guidance. The resources that women receive in the clinical setting need to carry forward to when they are making contraceptive transitions outside of clinical contact. This anticipatory approach has been better developed for advance provision of emergency contraception, which is now available over the counter in the United States (Cleland et al. 2016). A similar approach to increasing access to ongoing hormonal contraceptive methods outside of the clinical setting is needed. While some have advocated for over-the-counter access for the contraceptive pill, these efforts have not yet been successful in the United States (Grossman 2008). Recent state-level policy changes in several states including Oregon have made the pill more accessible in pharmacies without having to visit a physician or other advance practice clinician for a prescription (Rodriguez et al. 2016). This approach could provide additional needed support for women to use contraceptive methods with minimal pregnancy risk when they are not in contact with the clinical care system.

Additional approaches to supporting women's contraceptive use when they are outside the clinical setting may include building the capacity of community-based professionals who work with adolescents and young adults in other capacities on a day-to-day basis to provide supportive pregnancy prevention resources. Prior research suggests that in a broad range of community-based organisations, professionals who work with youth already have conversations about relationships and sexual health (Fisher et al. 2012). Success of a recent intervention to develop the capacity of youth-serving professions to discuss sexual health issues with young men and refer them to clinical sexual and reproductive healthcare services (Marcell et al. 2016) could be translated to improving community-based contraceptive supports for young men and women.

With respect to research and policy, a better understanding of the association between sexual activity and contraceptive use may be useful when analysing user-group-specific failure rates and creating strategies around reducing failure of specific methods. Annual failure rates depend on frequency of sexual activity, as women who have sex more often are more often at risk of event-level method failure. Part of the differences in specific method failure rates could consequently be in part due to differences in frequency of sexual activity while women are using those methods. Furthermore, differences in specific method failure rates between groups of people according to characteristics such as age and relationship type may be in part due to variation in frequency of sexual activity (Kost et al. 2008). Removing this potential confounding by frequency of sexual activity from failure rate analyses may provide more useful information about other factors that contribute to increased method failure at the population level.

Our analyses provide a foundation for future study of a potentially causal association between sexual activity and contraceptive use by assessing the exposure and outcome within a timeframe that likely corresponds to how health behaviour decisions are made. By identifying the associations between sexual activity and contraceptive method use at the level of weekly observation, this study goes beyond prior research in this area and provides insight into how women make contraceptive decisions. Our study underscores the importance of investing in detailed longitudinal research projects. Rich data sources, such as the RDSL allow us to more fully understand women's sexual and reproductive health behaviours. These study findings provide the basis for improving sexual and reproductive health services, formulating supportive policies, and supporting women's reproductive right to decide if and when to become pregnant.

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Table 1.

Baseline characteristics of women (n=737) during the study

Characteristic	Baseline prevalence % (n) or mean (SD)	
Age	19.2	(0.57)
Race/ethnicity		
White	59.0	(435)
Black	30.1	(222)
Hispanic	8.8	(65)
Other	2.0	(15)
HS GPA	3.1	(0.62)
Post-sec enrollment		
No	45.2	(333)
Yes	54.8	(404)
Highly religious		
No	44.5	(328)
Yes	55.5	(409)
Ever public assistance		
No	72.0	(531)
Yes	28.0	(206)
First sex <=15		
No	64.6	(476)
Yes	35.4	(261)
Ever pregnant		
No	72.2	(532)
Yes	27.8	(205)
Multiple past partners		
No	32.0	(236)
Yes	68.0	(501)

Table 2.

Weekly partnership characteristics (n=24,533 weeks)

Characteristic	Prevalence % (n) or mean (SD)	
Relationship type		
Casual	8.2	(2,013)
Nonexclusive dating	5.6	(1,374)
Long distance	17.5	(4,294)
Exclusive dating	33.0	(8,085)
Cohabiting	18.4	(4,526)
Married/engaged	17.3	(4,241)
Ever broken up		
No	80.2	(19,670)
Yes	19.8	(4,863)
Relationship duration in months	20	(20)
Ever pregnant with current partner		
No	83.2	(20,420)
Yes	16.8	(4,113)
Partner 3+ years older		
No	74.2	(18,194)
Yes	25.8	(6,339)
Partner more educated		
No	87.0	(21,343)
Yes	13.0	(3,190)
Partner has prior children		
No	91.3	(22,398)
Yes	8.7	(2,135)
Partner may want a pregnancy right now		
No	93.8	(22,973)
Yes	6.2	(1,520)

Table 3.

Week-level, partnership-level, and woman-level sexual activity and contraceptive use

Measure	Week level (n=24,533) %	Partnership level (n=2,004) mean (SD)	Woman level (n=737) mean (SD)
Sexual activity	64.9%	60.4% (39.1%)	69.2% (26.5%)
Contraceptive use			
Least effective	26.4%	29.4% (29.6%)	28.7% (31.9%)
Condoms	25.0%	32.9% (42.0%)	29.6% (34.3%)
Pills	41.8%	31.3% (42.3%)	33.1% (38.0%)
Highly effective	6.9%	6.3% (21.1%)	8.6% (22.0%)

Table 4.

Unadjusted multinomial logistic regression model for the probability of specific method use in relation to sexual activity (N=737 women; n=24,464 weeks)

	RRR [95% BCa CI] ^a			<i>p</i> -value for differences between methods
	Condom vs. least effective	Pill vs. least effective	Highly effective vs. least effective	
Week-level sexual activity	1.83 [1.64–2.10] ***	1.86 [1.66–2.13] ***	2.17 [1.74–3.51] ***	0.51
Partnership-level sexual activity ^b	1.05 [1.01–1.11] *	1.09 [1.04–1.14] ***	1.10 [1.02–1.18] *	0.18
Between-women sexual activity ^b	0.92 [0.86–0.99] *	1.07 [0.98–1.15]	1.21 [1.06–1.36] ***	<0.001
<i>p</i> -value for differences between levels ^c	<0.001 ^d	0.54	0.22	

* *p*<0.05

** *p*<0.01

*** *p*<0.001

^a Bootstrapped bias corrected and accelerated confidence intervals

^b Proportion of partnership weeks sexually active is scaled by 10 so that RRR estimates refer to relative increases per 10% increase in proportion of weeks sexually active.

^c Test for equality of the three unscaled week-level, partnership-level and between-women effects

^d Pairwise comparisons of effects on condom use indicated significant differences between week-level and between-women effect (*p*<0.001) and between-women and partnership-level effect (*p*=0.002), but no difference in week-level and partnership-level effects (*p*=0.70)

Table 5.

Adjusted multinomial logistic regression models for the probability of specific method use in relation to sexual activity (N=737 women; n=24,433 weeks)

	RRR [95% BCa CI] ^a			<i>p</i> -value for differences between methods
	Condom vs. least effective	Pill vs. least effective	Highly effective vs. least effective	
Week-level sexual activity	2.00 [1.73–2.31] ***	2.00 [1.71–2.32] ***	2.49 [1.90–3.82] ***	0.43
Partnership-level sexual activity^b	1.06 [1.02–1.11] **	1.11 [1.04–1.16] ***	1.11 [1.02–1.21] *	0.23
Between-women sexual activity^b	0.98 [0.91–1.06]	1.12 [1.03–1.21] *	1.24 [1.09–1.41] ***	<0.001
Age (years)	0.97 [0.82–1.15]	0.90 [0.76–1.08]	0.95 [0.71–1.25]	
Race/ethnicity				
White	ref	ref	ref	
African-American	0.79 [0.49–1.23]	0.43 [0.24–0.69] ***	1.15 [0.44–2.07]	
Other	0.63 [0.29–1.38]	0.99 [0.53–1.83]	0.48 [0.17–1.44]	
Post-sec enrollment	0.93 [0.62–1.36]	1.20 [0.80–1.78]	1.28 [0.73–2.34]	
HS GPA (points)	1.55 [1.11–2.09] **	2.73 [1.86–3.83] ***	1.38 [0.91–2.50]	
Highly religious	1.08 [0.73–1.56]	0.99 [0.68–1.55]	0.50 [0.26–1.05]	
Ever public assistance	1.19 [0.80–1.75]	0.85 [0.53–1.25]	2.74 [1.52–5.57] ***	
Multiple past partners	0.60 [0.42–0.91] *	0.86 [0.56–1.31]	0.88 [0.33–2.23]	
Sex before age 16	0.91 [0.59–1.37]	0.99 [0.65–1.58]	1.02 [0.51–1.99]	
Relationship type				
Casual	ref	ref	ref	
Non-exclusive dating	0.76 [0.58–0.99]	1.00 [0.73–1.37]	1.03 [0.48–1.99]	
Long distance	1.16 [0.76–1.76]	1.05 [0.72–1.52]	1.85 [0.94–3.86]	
Exclusive dating	1.06 [0.70–1.53]	1.15 [0.78–1.68]	1.35 [0.66–2.73]	
Cohabiting	0.80 [0.45–1.31]	0.95 [0.61–1.56]	1.04 [0.45–2.27]	
Married/engaged	0.61 [0.34–1.14]	0.65 [0.38–1.07]	1.33 [0.53–3.62]	
Relationship duration (per month)				
0–12 months	0.98 [0.94–1.01]	1.03 [1.00–1.07]	1.01 [0.95–1.06]	
>12 months	1.02 [0.98–1.07]	0.97 [0.93–1.01]	1.00 [0.95–1.08]	
Ever pregnant with current partner	0.62 [0.42–0.98] *	0.66 [0.43–1.05]	0.57 [0.27–1.03]	
Partner is older	0.67 [0.48–0.99] *	0.81 [0.54–1.24]	0.83 [0.41–1.41]	
Partner more educated	0.83 [0.57–1.23]	0.82 [0.52–1.30]	0.88 [0.47–1.76]	
Partner has prior kids	1.05 [0.69–1.70]	0.86 [0.55–1.44]	1.68 [0.96–3.04]	
Partner does not want pregnancy	1.46 [0.95–2.04]	1.28 [0.65–2.06]	1.90 [0.94–3.47]	

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

^a Bootstrapped bias corrected and accelerated confidence intervals

^b Proportion of partnership weeks sexually active is scaled by 10 so that RRR estimates refer to relative increases per 10% increase in proportion of weeks sexually active.

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