

**Indirect Associations Between Infant Sleep, Parental Sleep, and Sexual Well-Being in New
Parent Couples**

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Abstract

New parents' sexual frequency and desire fluctuate throughout the transition to parenthood (i.e., the first year after childbirth). Poorer infant sleep and parental sleep are each associated with lower sexual frequency and desire in cross-sectional research. According to theory, infant sleep might shape new parents' sexual frequency and desire in so far as it disrupts parental sleep, though this pathway has yet to be examined. We examined the role of parental sleep in the indirect pathway between infant sleep and sexual frequency and sexual desire in couples, both within and between-person, during the first year postpartum. In a dyadic longitudinal study, 203 first-time mothers and their partners reported on infant sleep quality, parental sleep, sexual frequency, and sexual desire at 3-, 6-, 9-, and 12-months postpartum. Poorer infant sleep was associated with mothers' (within-couple) and partners' (between-couple) poorer sleep and, in turn, lower sexual frequency for the couple. For both mothers (within-person) and partners (between-person), poorer infant sleep was associated with their own lower sexual desire through poorer parental sleep via the indirect pathway. Ongoing assessment of infant sleep and parental sleep may reveal opportunities to mitigate the negative effects of poor sleep on new parents' sexual relationships.

Keywords: Transition to parenthood; Sexual Frequency; Sexual Desire; Infant Sleep; Sleep

Indirect Associations Between Infant Sleep, Parental Sleep, and Sexual Well-Being in New Parent Couples

The transition to parenthood—pregnancy through the first year postpartum—is marked by significant change in a couple’s relationship as parents adapt to new roles and responsibilities (Doss & Rhoades, 2017). New parents’ sexual relationships are particularly impacted; they report declines in sexual desire and frequency on average during this period (Rosen et al., 2020). These changes may be explained, in part, by disrupted sleep and fatigue resulting in less interest in, and energy for, sex. Fatigue and poor sleep are hallmark characteristics of new parenthood, with reductions in parents’ sleep duration and quality related to infants’ dysregulated sleep schedules (Loutzenhiser et al., 2015). There is preliminary evidence of associations between infant sleep and parental sleep, and between parental sleep and sexual frequency and desire (Afsahri et al., 2018; Loutzenhiser et al., 2015; Martínez-Martínez et al., 2017). Although there is limited evidence to suggest a direct effect of infant sleep on couples’ sexual frequency and desire, we propose that this relationship exists only via associations with parental sleep, which has not previously been tested.

Changes in Sexual Frequency and Desire in the Transition to Parenthood

Sexual frequency (i.e., how often sexual activity, including manual and oral stimulation and vaginal intercourse, occurs) and sexual desire (i.e., interest in sexual activity) can change in tandem during the transition to parenthood, though this is not always the case (Rosen et al., 2020). Indeed, these are distinct constructs; an individual may or may not choose to engage in sexual activity regardless of their level of desire (Meston & Buss, 2007). Changes in sexual desire and frequency may be an important protective factor during this stage of life, when parents focus their attention on caring for the infant (Lorenz et al., 2020). Still, a systematic review

concluded that 78% to 90% of couples resume vaginal intercourse by three months postpartum, and although sexual frequency increases over a year postpartum, it still does not resemble pre-pregnancy levels at 12 months (Jawed-Wessel & Sevick, 2017; Rosen et al., 2020). Although most couples resume sexual activity, an increase in sexual desire does not necessarily follow. For new mothers, declines in sexual desire typically begin in pregnancy and persist into the postpartum period (Rosen et al., 2020). While some research shows that male partners' sexual desire declines postpartum (Condon et al., 2004), other evidence suggests no changes (Rosen et al., 2020). Such findings reflect the variability in sexual experiences of predominantly male partners of women who gave birth.

New parents' sexual frequency and desire may fluctuate relative to the couple's typical levels, on average, over the transition to parenthood. An examination of within-person change over time may shed light on individual differences that would allow for more tailored interventions to support new parents. Fluctuations in sexual frequency and desire are likely to be influenced by individual factors, including indirect effects via characteristics of the infant such as sleep quality, though this possibility has not been previously tested. There is evidence that couples' relationship functioning (e.g., supportive exchanges, mood) may be higher or lower than average across the transition to parenthood (Ryon & Gleason, 2018). Thus, an approach that examines fluctuations in couples' sexual frequency and desire over the first year postpartum and accounts for factors associated with these fluctuations (i.e., within-person change) offers significant advantages to characterizing these changes above and beyond an examination of average differences (i.e., between-person change).

A Systems Model of Infant Sleep, Parental Sleep, and Sexual Desire and Frequency

The transactional systems theory of sleep-wake regulation suggests that interactions

between parents and the infant impact infant sleep and, in turn, the infant's sleep impacts parental sleep, fatigue, and well-being (Sadeh & Anders, 1993). These interactions are influenced by family-related factors, such as parents' knowledge and expectations about infant sleep and the relationship quality between parents. McDaniel and Teti (2012) extended this model by characterizing infant sleep as an external stressor that negatively influences parents' sleep, with subsequent consequences for the parental relationship. The authors found that poorer infant sleep predicted poorer parental sleep, which in turn was associated with more negative evaluations of the parenting relationship. Given that sexual satisfaction is one of the most robust predictors of relationship quality (Joel et al., 2020), and that fatigue and poor sleep have been linked to lower sexual desire and frequency in new parents (Schlagintweit et al., 2016), we expected sexual outcomes to be negatively associated with parental sleep stemming from poor infant sleep quality.

Infant Sleep, Parental Sleep, Sexual Frequency, and Desire

Research examining sexual frequency and desire during the transition to parenthood has largely focused on psychosocial and relational predictors of these outcomes, including stress, emotional support, and parents' perceptions of their relationship (Fitzpatrick et al., 2021). The association between sleep with sexual frequency and desire has received limited attention and no studies to our knowledge have examined the role of infant characteristics (i.e., infant sleep) as a precursor to these associations. Parents' sleep quality significantly decreases following the birth of their child, with the new infant's inconsistent sleep schedule implicated in parents' poor sleep (Gay et al., 2004; Loutzenhiser et al., 2015). In turn, shorter sleep duration is associated with poorer sexual function, including lower sexual desire (Afsahri et al., 2018). Qualitative and cross-sectional research show that parents identify fatigue as contributing to lower sexual

frequency and desire in the first year after birth (Fitzpatrick et al., 2021), though more so for new mothers than fathers (Afsahri et al., 2018; Ahlborg et al., 2005). Poor sleep in mothers who have given birth may be due to heightened stress and mood symptoms (Loutzenhiser et al., 2015), as well as breastfeeding, which includes frequent nighttime awakenings (Gay et al., 2004). Infant night awakenings may be less stressful for parents and preserve their relationship when parents respond to infant awakenings together and are responsive to each other's needs during these awakenings (Smallen et al., 2021). It is unclear however, how infant sleep quality is related to sexual outcomes via parental sleep alone, especially when other protective factors (e.g., parental support and bonding) are present which may suppress a direct association between infant sleep and sexual frequency and desire. Taken together, while theory and prior research do not suggest that infant sleep and sexual frequency and desire are directly related, parental sleep may play a critical role in connecting these factors.

Despite the dyadic nature of sexual frequency and desire, prior studies examining associations with parental sleep have focused only on one parent and neglected the interdependence of partners. Moreover, the lack of longitudinal studies precludes examinations of variability within-couples over time, thereby limiting our understanding of how fluctuations in these factors at different timepoints throughout the transition to parenthood may be linked to sexual frequency and desire. Such knowledge has implications for assessment and intervention to promote new parent couples' sexual well-being, especially if one parent's poor sleep has consequences for the other parent.

The Current Study

While there is support for the detrimental effects of infant sleep and parental sleep on the parenting relationship more broadly (Afsahri et al., 2018; Loutzenhiser et al., 2015), to our

knowledge, no prior studies have examined how infant sleep may relate to changes in sexual frequency and desire among new parents by way of parental sleep. The current study examined whether parental sleep is implicated in the indirect pathway between infant sleep and sexual frequency and sexual desire across 3-, 6-, 9-, and 12-months postpartum.

We hypothesized that poorer infant sleep would have an indirect effect on couples' lower sexual frequency and on mothers' and partners' lower desire by way of their own poorer sleep (i.e., people would engage in sex less frequently and report lower sexual desire due to poor sleep). We also examined an indirect effect by way of a partner's poorer sleep (i.e., people would report lower sexual desire due to their partner's poor sleep) in an exploratory manner. We expected all effects at both the within- and between-person levels. That is, we expected that people would have sex less frequently and feel less sexual desire at time points when their infant had slept worse and they in turn had poorer sleep than usual (within-person effects), but also that people who tended to have infants who slept worse and had poorer sleep as a result would engage in less frequent sex and feel less sexual desire across time points than people whose infants slept better and who experienced better sleep (between-person effects). We accounted for other key variables—pain during vaginal intercourse and breastfeeding—associated with sexual frequency and desire during the postpartum period (Fitzpatrick et al., 2021), by testing our main hypotheses controlling for these variables. We also controlled for demographic and couple characteristics, including age and relationship duration.

Method

Our study hypotheses, methods, and analysis plan were preregistered prior to analysis (but not data collection). The preregistration, data, and syntax, as well as a description of previous publications with the dataset, are available on the Open Science Framework:

https://osf.io/cvrmx/?view_only=4af6f58e3ff84c65a9fa710146229082 (MacKenzie et al., 2022).

Participants and Procedure

Recruitment took place between May 2016 and April 2018. Participants were first-time mothers and their partners recruited between weeks 13 and 24 of their pregnancy ($M = 19.39$, $SD = 1.56$). Participants were recruited online (40.0%), in-person during an ultrasound appointment at a local health centre (15.3%), through study flyers in their doctor's office (17.7%), and by community advertising and word of mouth (26.9%). Inclusion criteria were (1) age of 18 years or older; (2) first-time pregnancy and/or birth; (3) healthy, singleton pregnancy; (4) relationship with partner of at least six months; (5) fluency in English; and (6) access to personal emails.

A total of 268 couples were screened for participation and 252 were enrolled. Ultimately, 215 couples completed the study and 203 couples were included in the current analysis (see Supplemental Figure 1 for participant flowchart). Participants mostly identified as heterosexual (90% of women, 96% of partners), were married (91%) and in their current relationship for an average of 6.5 years, and on average 30 years of age ($SD = 4.60$), Canadian (71.6%, $n = 308$), and White (80.5%, $n = 346$). Most had earned a post-secondary degree, had full-time employment, and couples' average income was more than \$60,000 (see Supplemental Table 1 for sociodemographics). When comparing participants retained versus withdrawn from analyses, there were no differences in any of the key study variables, however, those withdrawn were more likely to be from Canada, (89.7%), $\chi^2(1) = 4.22$, $p = .04$, and partners were less likely to identify as heterosexual (71.4%), $\chi^2(1) = 17.83$, $p < .001$.

Research ethics board approval was granted from Dalhousie University and the University of Toronto Mississauga. Study eligibility was confirmed by a research assistant and informed consent was given by participants online prior to commencing study participation.

Surveys were administered online via Qualtrics and couples were instructed to complete their surveys independently. The baseline survey, which collected demographic information, was completed between 18 and 24 weeks of pregnancy. Follow-up surveys including the measures of infant sleep, parental sleep, sexual frequency and desire were completed at 3-, 6-, 9-, and 12-months postpartum. A pre-minder email was sent to participants one week prior to each survey and participants received telephone reminders if they did not complete their survey within 48-72 hours and again one and three weeks later. Each participant received a gift card valued up to \$105 CDN for completed surveys.

Measures

Infant Sleep Quality

Infant sleep quality was assessed with a single item developed by the study team based on prior research (e.g., Hipp et al., 2012). Prior research has shown single-item measures of infant sleep to be significantly correlated with parental sleep and sexual desire (Hipp et al., 2012; Loutzenhiser et al., 2015). Participants rated the quality of their infants' sleep over the preceding four weeks on a scale from 0 ("terrible quality of sleep") to 10 ("great quality of sleep"). Both parents' reports of infant sleep quality were strongly correlated at all time-points (r s ranged from .49 to .60, all $p < .001$). These correlations align with other research showing that parents have similar ratings of their infants' sleep (Muscat et al., 2012). Therefore, in line with our pre-registered plan, we took the average of mothers' and partners' ratings and used the couple-level variable for infant sleep quality, with higher scores indicating better quality infant sleep.

Parental Sleep

Parental sleep was assessed with two items used in prior research (Hipp et al., 2012; Rosen et al., 2017), which have previously been found to be associated with sexual frequency

and desire (Vannier et al., 2018). Participants rated their fatigue in the past four weeks on a scale from 1 (“extreme fatigue”) to 7 (“high energy”), as well as their average sleep quality on a scale from 0 (“terrible sleep quality”) to 10 (“great sleep quality”). Sleep quality and fatigue were strongly correlated at all timepoints for mothers (r_s ranged from .53 to .59, all $p < .001$) and partners (r_s ranged from .61 to .67, all $p < .001$). Consistent with our pre-registered plan, and because these items were highly correlated across all timepoints for each parent, we re-scaled the average sleep quality variable to have the same range as the fatigue variable (rescaling formula used was $(7-1)*(original\ variable-0)/(10-0)+1$, where 7 refers to the fatigue denominator and 10 refers to the sleep quality denominator; formula repeated for each timepoint). The variables were then averaged to create a single score, with higher scores reflecting better sleep.

Sexual Frequency

Sexual frequency was assessed with the *Sexual Frequency Questionnaire* (Rosen et al., 2020). Participants rated the frequency of their sexual behaviors during the preceding four weeks, including oral sex (giving and receiving), manual stimulation (giving or receiving), intercourse with vaginal penetration, and intercourse with anal penetration, on a scale from 1 (“once or twice”) to 6 (“more than once a day”). These items demonstrated strong internal consistency for mothers and partners (Cronbach’s alpha = .83 to .87 and .84 to .89, respectively). Ratings were averaged and total scores ranged from 1 to 6, where higher scores indicated more frequent and varied sexual activity. Both parents’ ratings of sexual frequency were significantly correlated at all timepoints (r_s ranged from .58 to .75, all $p < .001$). Given the correlations between partners, and that sexual frequency was assessed only for partnered sexual activities, we used the average of mothers’ and partners’ ratings as a couple-level variable.

Sexual Desire

Female participants completed the two validated desire items from the *Female Sexual Function Index* (FSFI; Rosen et al., 2000) and male participants completed the nearly identical two desire items from the *International Index of Erectile Function* (IIEF; Rosen et al., 1997). Participants rated how often they felt sexual desire in the preceding four weeks on a scale from 1 (“almost never or never/very low or none at all”) to 5 (“almost always or always/very high”). The two items were summed, and totals could range between 2 and 10, with higher scores indicating greater desire. The FSFI items were strongly correlated at all timepoints (r s ranged from .81 to .86, all $p < .001$), as were the IIEF items (r s ranged from .76 to .81, all $p < .001$).

Breastfeeding

At each time-point, mothers reported whether or not they breastfed in the past two weeks.

Pain During Vaginal Intercourse

Pain during vaginal intercourse was assessed in mothers using the FSFI pain subscale (Rosen et al., 2000), comprised of three items reflecting the frequency and degree of pain during and following vaginal intercourse in the preceding four weeks. This scale was rated from 1 (“almost always/very high pain”) to 5 (“almost never or never/very low or none at all”). Women who reported no sexual activity in the previous four weeks were scored as missing to avoid bias (Meyer-Bahlburg & Dolezal, 2007). Items were summed to produce a pain score ranging from 3 to 15, where higher scores indicated lower pain. The FSFI pain items showed strong internal consistency (Cronbach’s alpha = .94 to .96).

Data Analyses

To begin, we calculated correlations among all variables at the within- and between-couple level (see supplemental Table 2). Within-couple variables were calculated using a repeated-measures correlation approach (Bakdash & Marusich, 2017), run via the rmcrr Shiny

App (https://lmarusich.shinyapps.io/shiny_rmcrr/).

We conducted multilevel mediation analyses to examine the mediating role of parental sleep in the association between infant sleep and parental sexual frequency and sexual desire, by way of testing the indirect pathways in these respective models. We examined this model both within time-points (within-person/couple effects) and across time-points (between person/couple effects). For sexual frequency, which was a couple-level variable, we ran a two-level distinguishable model with time nested within couples (Bolger & Laurenceau, 2013) using SPSS v. 26. Couples were distinguished by their birth status (birth mother versus partner). Specifically, we examined: (1) the impact of infant sleep quality on the birth mother and partner's sleep; (2) the impact of mother and partner sleep on couple-level sexual frequency; and (3) the impact of each parents' sleep on their overall couple-level sexual frequency, controlling for infant sleep. We then used the SPSS macro MLMED (Rockwood, 2017) to test the indirect effect of parental sleep in the association between infant sleep quality and couples' sexual frequency (Figure 1a). Confidence intervals of indirect effects that did not include 0 were considered significant.

For sexual desire, which was an individual-level variable, we used a two-level crossed model with distinguishable dyads in order to adjust for non-independency in each partner's sexual desire within both time and couple. We tested: (1) the impact of infant sleep quality on each parents' sleep; (2) the impact of individual-level parental sleep on each parents' individual-level sexual desire, including effects on the actor (i.e., a parent's impact on their own outcome) and on the partner (i.e., a parent's impact on their partner's outcome); and (3) the impact of each parent's individual-level sleep on each parent's individual-level sexual desire, controlling for infant sleep quality. Then, we ran a multilevel model to examine if there was an indirect association between infant sleep and both one's own and one's partner's desire through each

parent's sleep (Figure 1b). The MLMED program cannot model the crossed residual variances and covariances of the sexual desire model, so we took a two-pronged approach to conducting this test. We tested the indirect effects separately for mothers and partners within MLMED (nesting time within individual) and we also ran the full model without random slopes using the Monte Carlo Method for Assessing Mediation (MCMAM; Selig & Preacher, 2008) to ensure robustness of the indirect effects (for the same approach, see Carswell et al., 2021). Confidence intervals of indirect effects that did not include 0 were considered significant. We report the results of the full model tested using MCMAM in the main results as well as the confidence intervals for the indirect effects from MLMED. We summarize all MLMED results here and have included the corresponding tables in supplemental materials.

All analyses for the sexual frequency (couple-level) models were run with an unstructured variance-covariance matrix for random effects in the sexual desire models; compound symmetry matrices with heterogeneous variances were modeled and random effects were estimated separately for each partner with similar effects (e.g., intercepts, slopes for same variable) covarying in a blocked random effects design. When models were unable to converge, covariances between random effects with little variance, followed by random variances, were removed. Degrees of freedom were calculated using Satterthwaite approximation in SPSS to generate degrees of freedom between the number of repeated measures and participants. Consistent with our preregistered analytic plan, covariates of breastfeeding, women's pain during intercourse, and key demographic variables (e.g., age, relationship duration) that were significantly associated with our outcome variables (i.e., $r > .30$), were included in subsequent analyses to rule out alternative explanations.

Results

Sexual Frequency

Associations among infant sleep, parental sleep, and sexual frequency

Descriptive statistics for all variables are presented in Supplemental Table 1. Results from multilevel models showed that during timepoints when infant sleep was poorer, mothers and partners experienced significantly poorer sleep, both within and between couples (Table 1). That is, parents reported poorer sleep (i.e., worse sleep quality and greater fatigue) when their infants were sleeping worse than typical, and parents whose infants tended to sleep worse experienced poorer sleep than parents whose infants tended to sleep better. There was a trending significant association between mothers' poorer sleep and couples' lower sexual frequency within-couple ($p = .05$). Partners' poorer sleep was significantly associated with couples' lower sexual frequency between-couple (there was no within-couple association). In other words, couples in which partners tended to experience poorer sleep engaged in sexual activity less frequently than couples in which partners tended to have better sleep. When looking directly from infant sleep to sexual frequency, we found no significant association. Thus, we turned to examining whether infant sleep would have indirect effects on sexual frequency through parental sleep.

Indirect effect of infant sleep on sexual frequency via parental sleep

For mothers' sleep, our indirect pathway hypothesis was partially supported (for path estimates from MLMED, see supplemental Table 3). Although the path from mothers' sleep to sexual frequency approached significance ($p = .05$), there was a significant indirect effect of infant sleep on couples' sexual frequency through mothers' sleep within couples (Table 1). For partners, there was a significant indirect effect between couples, such that poorer infant sleep was associated with couples' lower sexual frequency by way of partners' poorer sleep.

In sum, we found evidence of within-couple indirect effects for mothers' sleep and between-couple indirect effects for partners' sleep. That is, couples tended to have less sex at timepoints when infants slept worse than usual and this association was explained in part by mothers reporting worse sleep than usual. In addition, couples tended to have less sex when their infants tended to sleep poorly, compared to couples whose infants tended to sleep better, and this association was explained in part by partners reporting poorer sleep.^{1,2}

Covariate Analyses

Pain during vaginal intercourse was significantly correlated with sexual frequency ($r = .56, p < .001$ between-couples; $r = .10, p < .05$ within couples), mothers' sleep ($r = .17, p < .05$; between couples), and partners' sleep ($r = .19, p < .001$; between couples; see Supplemental Table 2). When pain during intercourse was added to the indirect pathway model, the indirect effect of poorer infant sleep on couples' lower sexual frequency through mothers' poorer sleep (within-couple) was no longer significant (Supplemental Table 4). The indirect effect of poorer infant sleep on couples' lower sexual frequency through partners' poorer sleep (between-couple) remained significant. Consistent with our preregistered analytic plan, we did not test breastfeeding, relationship length, or participant age as covariates given that their correlations with sexual frequency were less than 0.30.

Sexual Desire

Associations among infant sleep, parental sleep, and parental desire

¹ This test of the indirect pathway was re-run with parental sleep quality and fatigue as separate variables; the indirect effect between infant sleep and sexual frequency, by the way of mothers' sleep quality (within-couple) was no longer significant, however the size of the parameter estimate was unchanged for sleep quality ($b = .01, p = .093$) and fatigue ($b = .01, p = .056$). The association between partner sleep and sexual frequency remained significant.

² Given that partners' reports of sexual frequency were only moderately correlated ($r_s = .58-.75$), the test of the indirect pathway was re-run with each parents' rating of sexual frequency as the outcome variable; significant individual path estimates remained the same; the indirect effect between infant sleep and sexual frequency by way of mothers' sleep quality (within-person) was no longer significant, however the size of the parameter estimate was unchanged ($b = .01, p = .152$). The association between partner sleep and sexual frequency remained significant.

As with the couple-level analyses, we found significant within- and between-person associations between infant sleep and both mothers' and partners' sleep (Table 2). There was a significant within-person association between mothers' poorer sleep and their own lower sexual desire; however, this effect was not found at the between-person level. Thus, when mothers experienced poorer sleep than usual, their desire was significantly lower. In addition, there was a significant between-person association between partners' poorer sleep and their own lower desire, indicating negative effects on desire when averaged across timepoints. One partner's sleep was not associated with the other's sexual desire (i.e., no significant cross-partner effects). When looking directly from infant sleep to sexual desire, we found no significant associations with either parent's report (Table 2; see Supplemental Table 5 for indirect pathway estimates). Thus, we turned to examining whether infant sleep would have indirect effects on sexual desire through parental sleep.

Indirect effect of infant sleep on sexual desire via parental sleep

Consistent with the sexual frequency findings, and in support of our key hypothesis, there was an indirect effect at the within-person level of infant sleep on mothers' own desire via mother's sleep, and an indirect effect at the between-person level of infant sleep on partners' own desire via partner's sleep (see Table 2; for exact MLMED path estimates, see Tables 7 and 8 in the supplement). There was no evidence of cross-partner effects (i.e., one parent's sleep explaining associations between infant sleep and sexual desire for the other parent).³

Covariate Analyses

Pain during vaginal intercourse was significantly correlated with mothers' sexual desire between-person ($r = .48, p < .001$) but not within-person (see Supplemental Table 2). When pain

³ As with sexual frequency, the tests of the indirect pathways were re-run with parental sleep quality and fatigue as separate variables. The results remained the same for both parents using each of the individual items.

during intercourse was added to the sexual desire indirect pathway model, all significant effects were retained (Supplemental Table 6). Breastfeeding, relationship length, and participant age were not entered as covariates given that their correlations with sexual desire were less than 0.30 (Supplemental Table 2).

Discussion

Past research examining the sexual well-being of new parents has been largely cross-sectional, focused on the mothers' experience only, and has examined parental psychosocial and relational predictors with a limited investigation of sleep (e.g., Hipp et al., 2012; Martínez-Martínez et al., 2017). We did not find direct associations between infant sleep and parental sexual frequency or desire, which was expected given the likely presence of potential suppressors such as parental bonding and support. Rather, the current results position poor quality of infant sleep as one novel factor involved in the pathway toward lower sexual frequency and desire during the transition to parenthood. Specifically, when infants had poorer sleep, their parents also reported poorer sleep, which was in turn associated with couples' lower sexual frequency and sexual desire. For mothers, at the within-couple level, when couples reported their infant was sleeping worse than usual, mothers also tended to report sleeping worse than usual, and this helped explain their lower-than-usual sexual frequency and mothers' lower sexual desire. We also found some evidence for effects at the between-couple level for partners, such that couples who reported that their infants tended to sleep poorly across timepoints had partners who tended to report sleeping worse on average. This helped explain the fact that these couples reported having less frequent sex and the partners in these couples tended to have lower sexual desire than couples whose infants (and partners) generally slept better. Overall, the effects for partners tended to be more robust than the effects with mother's sleep, particularly for sexual

frequency. When looking across partners, neither parent's sleep was associated with lower sexual desire in the other parent when accounting for the parent's own sleep.

Individual Pathways for Infant Sleep, Parental Sleep, and Sexual Frequency and Desire

As expected, poorer infant sleep was linked to poorer parental sleep for mothers and partners, both on average over time and when their sleep was worse than usual. These results align with prior research demonstrating that poor infant sleep disrupts parental sleep (Sinai & Tikotzky, 2012), which makes parents more fatigued (Gay et al., 2004). Additionally, poorer sleep was associated with lower sexual frequency for the couple. For sexual desire, when mothers had poorer sleep than usual throughout the postpartum period and partners had poorer sleep overall, they each reported lower sexual desire. These associations between poorer parental sleep and lower sexual frequency and desire are also consistent with prior cross-sectional research (Ahlborg et al., 2005; Hipp et al., 2012). The current findings extend this literature by demonstrating within-person variability in sleep and sexual outcomes throughout the transition to parenthood, suggesting that new parents' experiences fluctuate during this vulnerable period, and these fluctuations are especially important for mothers' sexual desire. This information may be reassuring for new parents at times when disruptions to infant sleep and parental sleep are especially common and may feel overwhelming. Future research might also examine other aspects of sexual well-being (e.g., satisfaction) to create a more comprehensive understanding of sexual outcomes in relation to infant and parental sleep.

Infant Sleep and Sexual Frequency are linked via Parental Sleep

Couples tended to have sex less frequently when infants slept worse than usual in part because mothers reported worse sleep than usual. In addition, couples tended to have less sex when their infants tended to sleep poorly compared to couples whose infants tended to sleep

better, and this association was explained in part by partners reporting poorer sleep overall. However, the indirect effect via mothers' poorer sleep was no longer significant when pain during vaginal intercourse was added to the model. This result suggests that the link between pain and sexual frequency was stronger than that of mothers' sleep and sexual frequency (Rosen & Pukall, 2016), and that, overall, the effect via partners' sleep was more robust. Poorer sleep may lead new parents to initiate sexual activity less frequently and this may be especially true for partners—the majority of whom identified as fathers—given that men, on average, initiate sexual activity more frequently than women (Vannier & O'Sullivan, 2011). While these results do not directly relate to the subset of couples whose partners did not identify as fathers, the new experience of parenthood for partners relative to the parent who gave birth may still apply as they are having this experience of disrupted sleep likely for the first time.

Infant Sleep and Sexual Desire are linked via Parental Sleep

When infants slept more poorly than usual, mothers slept more poorly than they typically did, and in turn, reported lower sexual desire. For partners, we observed this pattern when sleep was averaged across all time points, suggesting that when infants slept more poorly on average, partners who experienced poorer sleep tended to have lower sexual desire than those who tended to have better sleep. These effects remained significant when controlling for pain during intercourse. There was no evidence of an indirect pathway via parental sleep on the sexual desire of the other parent. Although our findings cannot speak directly to why parental sleep is associated with lower sexual desire, one explanation for these associations may be the heightened stress of new parenthood coupled with disruptions to parents' capacity for emotion regulation. When infants sleep poorly and parents experience poorer sleep as a result, emotional resources are strained and it may become increasingly difficult to manage emotions (Palmer &

Alfano, 2017). Prior research links poorer emotion regulation to lower sexual desire (Dubé et al., 2020). Difficulties regulating negative emotions are thought to increase sensitivity and reactivity to negative stimuli (e.g., conflict with the other parent) and promote the use of less adaptive coping strategies (e.g., avoidance of intimacy) resulting in lower sexual desire (Rosen & Bergeron, 2019). Considering the additional association between overall physical fatigue and decreased desire (Woolhouse et al., 2012), the combination of fatigue and reduced emotional regulation may have cumulative negative effects for sexual desire. Given that one parent's sleep was not associated with the sexual desire of the other, the identified pathway appears to be specific to each parents' personal experience.

Within versus between-couple effects

Overall, we consistently saw within-person effects for mothers and between-person effects for partners in our results for both sexual frequency and sexual desire. This pattern means that when mothers slept more poorly than usual, they reported lower sexual desire and the couple engaged in sex less frequently and that when partners slept more poorly overall, they reported lower sexual desire and the couple engaged in less frequent sex. For mothers, gendered roles including responsibility for providing nurturance to both the infant and partner, division of labor, body objectification, and expectations for sexual initiation, are all associated with lower sexual desire in women (van Anders et al., 2021). These factors are likely to be even more salient during the transition to parenthood, as mothers typically engage in more caregiving and labor relative to partners (Kotila et al., 2013). In addition, greater parental response to infant nighttime awakenings, which is more common among breastfeeding mothers, is associated with worsened sleep quality (Gay et al., 2004). All of the aforementioned factors are likely to fluctuate considerably depending on context which can vary over time, thus potentially contributing to the

within-person effects observed for mothers but not partners. In contrast, partners showed less variability within-person, but rather it was their average sleep experience over time relative to other partners that mattered for their eventual sexual frequency and sexual desire.

Theoretical and Clinical Implications

The associations between infant sleep, parental sleep and sexual outcomes are in line with McDaniel and Teti's (2012) family systems model, which conceptualizes poor infant sleep as an external stressor that negatively influences parents' sleep and subsequently, their relationship. We extended this model by applying it to a novel and important aspect of the parents' relationship: their sexual relationship. An enhanced understanding of factors contributing to the sexual well-being of new parents' is critical as the sexual relationship serves as a protective factor for couples' overall health and relationship by promoting intimacy and closeness during a vulnerable period (Joel et al., 2020; Rosen et al., 2020). Thus, a reduction in sexual activity may serve as a protective factor for the relationship while new parents are prioritizing infant care and coping with sleep disruptions (Lorenz et al., 2020), which may be reassuring for couples. The present study cannot address whether lower sexual frequency/desire in response to sleep changes is protective for the couples' relationship, especially without considering other important aspects of their relationship. Still, couples, especially those suffering from poorer sleep, may wish to pay attention to sexual frequency and desire as they transition into parenthood and adjust their expectations in these areas. This may be a period where couples could benefit from lowering their sexual expectations and focusing instead on other aspects of relationship quality.

The evidence for within-couple variability, particularly for new mothers, in the associations among infant sleep, parental sleep, sexual frequency and desire highlights opportunities to better support parents during periods of disrupted sleep and increased fatigue.

By regularly assessing infant and parental sleep, clinicians are positioned to address the impacts of these two factors (among others), which may negatively impact couples' sexual relationships. Ongoing monitoring of infant and parental sleep and sexual frequency/desire is necessary as the present evidence suggests that they fluctuate in severity over the first 12 months postpartum. Providing information that poor sleep is not static may be reassuring to parents who feel particularly overwhelmed by this experience or who attribute their lack of desire to a poor relationship with their partner. There are evidence-based interventions targeting infant sleep that show improvements in parental mood and sleep (Field, 2017). Such interventions may hold promise for the sexual relationship and should be tested in future research, especially given the association between mood and sexuality in the transition to parenthood (Dawson et al., 2020).

Strengths and Limitations

To our knowledge, this study is the first to link couples' sexual frequency and desire in the postpartum period to infant characteristics, and specifically their sleep quality, via parental factors. This study had a large sample size of couples and strong retention over time, allowing us to examine each parent's experiences throughout the postpartum period, while controlling for interdependence between couple members. We also examined our hypotheses in terms of average levels for all couples, as well as the more individualized approach of fluctuations from one's own average over time. This study is not without its limitations. Numerous other factors are likely to contribute to new parents' sexual frequency and desire (e.g., relationship satisfaction) and controlling for such factors might provide stronger evidence for the importance of sleep. We utilized brief one- or two-item self-report measures of infant sleep and parental sleep to reduce participant burden. This approach is similar to other studies with new parents, which also found single item measures to be significantly associated with sexual frequency and

desire (Hipp et al., 2012; Loutzenhiser et al., 2015; Vannier et al., 2018). However, use of more comprehensive measures, including sleep disturbance, sleep efficiency, and daytime dysfunction, could inform a more nuanced understanding of how sleep relates to new parents' sexual outcomes. The study sample also consisted of predominantly heterosexual, White, married couples with moderate to high income. Our sample included few same-gender/sex partners, which precluded separate comparisons or an examination of partner gender as a moderator. Although there was limited variability in the income and ethnicity represented in the current sample, these factors are important to account for in future research with greater diversity given the associations between lower socioeconomic status and racialized status with poor sleep quality in prior research (Grandner et al., 2016). Additionally, these data were correlational and causal conclusions cannot be drawn. All variables in the tests of indirect pathways were assessed at the same time point rather than across time because we did not think that infant sleep would influence sexual outcomes three months later (i.e., we expected more proximal effects). Finally, use of online surveys is limited by expectancy effects or response biases that may have influenced responding.

Conclusion

New parent couples commonly report changes to their sleep patterns and sexual aspects of their relationship after the baby is born (Davis et al., 2004; Loutzenhiser et al., 2015; Rosen et al., 2020). This study documents, for the first time, that poorer infant sleep is associated with lower sexual desire and less frequent sex to the extent that it is linked to poorer parental sleep. The current findings highlight the importance of regular assessment and intervention to support parents in managing infant sleep and their own sleep, as such interventions may contribute to maintaining their sexual frequency and desire during the transition to parenthood.

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Table 1*Pathway Analyses between Infant Sleep, Parental Sleep, and Sexual Frequency*

Outcome		<i>b</i>	<i>SE</i>	95% CI	<i>df</i>	<i>t</i>	<i>p</i>
<i>Sexual Frequency ~</i>							
	Within	.04	.02	[-.001, .09]	115.30	1.95	.054
Mother Sleep	Between	.02	.06	[-.09, .14]	206.94	0.40	.688
	Within	.04	.02	[-.01, .08]	90.46	1.69	.096
Partner Sleep	Between	.20	.05	 [.10, .30]	203.67	3.84	<.001
<i>Mother Sleep ~</i>							
	Within	.27	.02	 [.22, .31]	583.41	12.15	<.001
Infant Sleep	Between	.23	.03	 [.16, .29]	208.51	6.84	<.001
<i>Partner Sleep ~</i>							
	Within	.18	.02	 [.13, .23]	102.87	7.59	<.001
Infant Sleep	Between	.20	.04	 [.12, .28]	199.98	4.90	<.001
<i>Sexual Frequency (Controlling for Infant Sleep) ~</i>							
	Within	-.002	.02	[-2947.40, 2947.39]	0.04	-0.15	.975
Infant Sleep	Between	-.02	.03	[-.09, .05]	113.01	-0.61	.542
	Within	.05	.03	[-.01, .10]	16.52	1.76	.096
Mother Sleep	Between	.04	.06	[-.08, .16]	204.94	0.62	.535
	Within	.03	.02	[-.04, .11]	3.33	1.43	.241
Partner Sleep	Between	.21	.05	 [.10, .31]	140.56	3.87	<.001

Test of Indirect Pathways from Infant Sleep to Sexual Frequency through Parental Sleep							
Direct Effects		<i>b</i>	<i>SE</i>	95% CI	<i>df</i>	<i>t</i>	<i>p</i>
<i>Sexual Frequency ~</i>							
Infant Sleep	Within	-.0003	.01	[-.03, .03]	516.07	-0.02	.981
	Between	-.01	.03	[-.08, .05]	202.61	-0.38	.703
Indirect Effects		<i>b</i>	<i>SE</i>	95% CI	<i>Z</i>	<i>p</i>	
<i>Sexual Frequency ~</i>							
Mother Sleep	Within	.01	.01	 [.001, .02]	2.14	.032	
	Between	.01	.01	[-.02, .04]	0.47	.636	
Partner Sleep	Within	.01	.004	[-.002, .01]	1.47	.141	
	Between	.04	.01	 [.02, .07]	2.89	.004	

Note. Bolded text indicates significant result. Indirect pathways tested using MLMED. For exact path estimates from MLMED analyses, see Supplemental Table 3.

Table 2*Pathway Analyses between Infant Sleep, Parental Sleep, and Sexual Desire*

Outcome		<i>b</i>	<i>SE</i>	95% CI	<i>df</i>	<i>t</i>	<i>p</i>
<i>Mother Desire ~</i>							
	Within	.21	.07	 [.07, .35]	178.19	3.01	.003
Mother Sleep	Between	.08	.16	[-.23, .39]	198.58	0.53	.597
	Within	.06	.07	[-.08, .21]	111.87	0.87	.386
Partner Sleep	Between	.11	.14	[-.17, .39]	197.51	0.76	.451
<i>Partner Desire ~</i>							
	Within	.05	.06	[-.06, .16]	143.77	0.93	.357
Mother Sleep	Between	.09	.14	[-.19, .37]	198.22	0.63	.530
	Within	.10	.06	[-.02, .23]	129.55	1.67	.098
Partner Sleep	Between	.58	.13	 [.33, .83]	196.72	4.57	< .001
<i>Mother Sleep ~</i>							
	Within	.27	.02	 [.22, .31]	575.98	12.07	< .001
Infant Sleep	Between	.23	.03	 [.16, .29]	208.95	6.94	< .001
<i>Partner Sleep ~</i>							
	Within	.18	.02	 [.13, .23]	104.80	7.61	< .001
Infant Sleep	Between	.20	.04	 [.12, .27]	200.75	4.89	< .001
<i>Mother Desire (Controlling for Infant Sleep) ~</i>							
	Within	.26	.08	 [.11, .41]	184.87	3.42	.001
Mother Sleep	Between	-.02	.17	[-.35, .31]	201.77	-0.13	.896
	Within	.08	.07	[-.07, .23]	123.27	1.10	.274
Partner Sleep	Between	.06	.14	[-.23, .34]	197.25	0.39	.696

		<i>b</i>	<i>SE</i>	95% CI	<i>df</i>	<i>t</i>	<i>p</i>
Infant Sleep	Within	-.06	.04	[-.14, .03]	519.52	-1.27	.205
	Between	.16	.09	[-.02, .34]	202.42	1.76	.081
<i>Partner Desire (Controlling for Infant Sleep) ~</i>							
Mother Sleep	Within	.05	.06	[-.07, .17]	178.67	0.81	.417
	Between	.09	.15	[-.21, .38]	200.16	0.56	.574
Partner Sleep	Within	.11	.06	[-.02, .24]	122.16	1.74	.085
	Between	.57	.13	 [.32, .83]	195.59	4.42	< .001
Infant Sleep	Within	-.004	.04	[-.08, .07]	141.56	-0.10	.920
	Between	.01	.08	[-.16, .17]	200.84	0.08	.935

Test of Indirect Pathways from Infant Sleep to Sexual Desire through Parental Sleep

Direct Effects							
<i>Mother Desire</i>							
Infant Sleep	Within	-.06	.04	[-.15, .03]	519.19	-1.38	.169
	Between	.16	.09	[-.02, .34]	202.59	1.74	.084
<i>Partner Desire</i>							
Infant Sleep	Within	.001	.04	[-.07, .07]	515.30	0.03	.973
	Between	.01	.08	[-.15, .17]	200.71	0.09	.927
Indirect Effects							
<i>Mother Desire</i>							
Mother Sleep	Within	.07	.02	 [.03, .11]	3.63	< .001	
	Between	-.004	.04	[-.08, .07]	-0.10	.918	
Partner Sleep	Within	.01	.01	[-.01, .04]	0.98	.325	
	Between	.01	.03	[-.05, .07]	0.37	.712	

<i>Partner Desire</i>		<i>b</i>	<i>SE</i>	<i>95% CI</i>	<i>Z</i>	<i>p</i>
	Within	.01	.02	[-.02, .05]	0.91	.362
Mother Sleep	Between	.02	.04	[-.05, .09]	0.56	.577
	Within	.02	.01	[-.001, .04]	1.83	.068
Partner Sleep	Between	.11	.03	 [.05, .19]	3.24	.001

Monte Carlo CI Calculation for
Significant Indirect Effects (95%)

<i>Mother Desire</i>	Within	[.04, .12]
Mother Sleep	Between	[-.07, .06]
<i>Partner Desire</i>	Within	[-.002, .04]
Partner Sleep	Between	[.05, .18]

Note. Bolded text indicates significant result. Indirect pathways tested using MLMED. For exact path estimates from MLMED analyses, see Supplemental Tables 7 and 8.

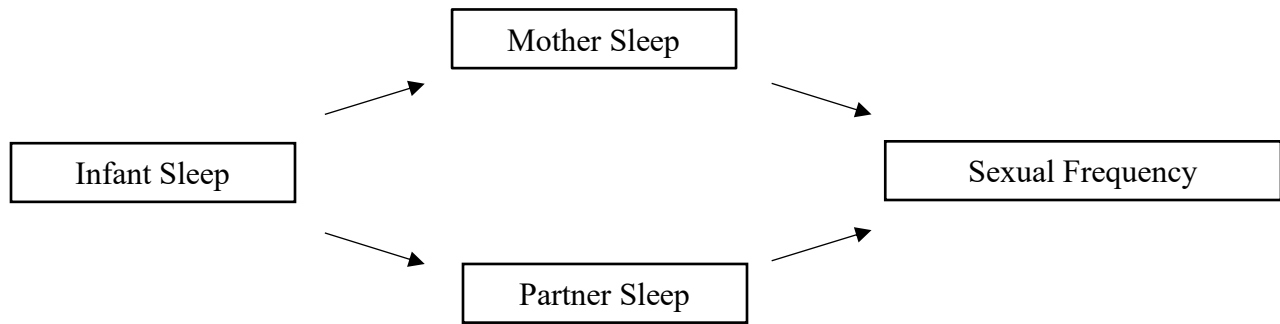


Figure 1(a)

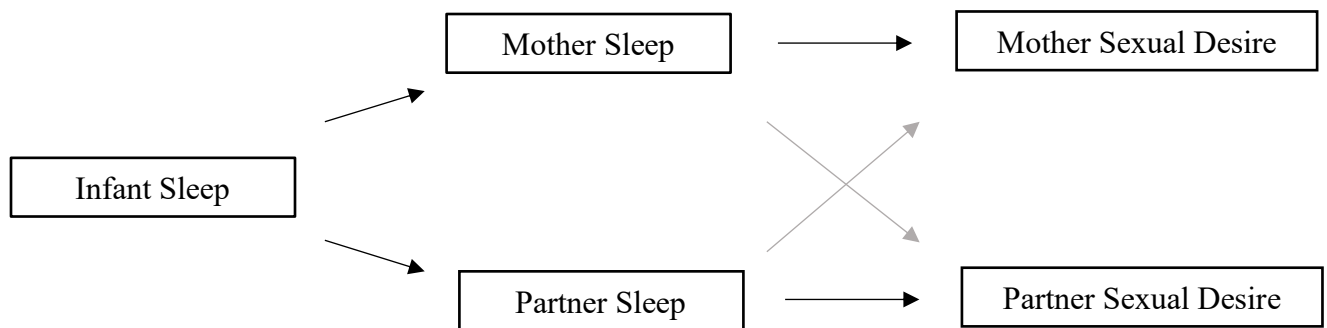


Figure 1(b)

Figure 1. (a) *Indirect pathway model with infant sleep as independent variable, parental sleep as indirect pathway variable, and sexual frequency as dependent variable.* (b) *Indirect pathway model with infant sleep as predictor, parental sleep as indirect pathway variable, and sexual desire as dependent variable. Grey lines indicate exploratory hypotheses.*