HHS Public Access
Author manuscript
*J Fam Psychol*. Author manuscript; available in PMC 2019 August 01.

Published in final edited form as:
*J Fam Psychol*. 2018 August ; 32(5): 622–631. doi:10.1037/fam0000422.

# Household Chaos and Family Sleep During Infants' First Year

**Corey J. Whitesell**,
The Pennsylvania State University

**Brian Crosby**,
The Pennsylvania State University

**Thomas F. Anders**, and
Brown University

**Douglas M. Teti**
The Pennsylvania State University

## Abstract

Household chaos has been linked with dysregulated family and individual processes. The present study investigated linkages between household chaos and infant and parent sleep, a self-regulated process impacted by individual, social, and environmental factors. Studies of relations between household chaos and child sleep have focused on older children and teenagers, with little attention given to infants or parent sleep. This study examines these relationships using objective measures of household chaos and sleep while controlling for, respectively, maternal emotional availability at bedtime and martial adjustment, in infant and parent sleep. Multilevel modeling examined mean and variability of sleep duration and fragmentation for infants, mothers, and fathers when infants were 1, 3, 6, 9, and 12 months (N = 167). Results indicated infants in higher chaos homes experienced delays in sleep consolidation patterns, with longer and more variable sleep duration, and greater fragmentation. Parent sleep was also associated with household chaos such that in higher chaos homes, mothers and fathers experienced greater variability in sleep duration, which paralleled infant findings. In lower chaos homes, parents' sleep fragmentation mirrored infants' decreasingly fragmented sleep across the first year and remained lower at all timepoints compared to parents and infants in high chaos homes. Collectively, these findings indicate that after controlling for maternal emotional availability and marital adjustment (respectively) household chaos has a dysregulatory impact on infant and parent sleep. Results are discussed in terms of the potential for chaos-induced poor sleep to dysregulate daytime functioning and, in turn, place parent-infant relationships at risk.

Correspondence concerning this article should be addressed to Douglas M. Teti, Department of Human Development & Family Studies, The Pennsylvania State University, University Park, PA 16802. dmt16@psu.edu.
Corey J. Whitesell, Brian Crosby, and Douglas M. Teti, Department of Human Development & Family Studies, The Pennsylvania State University; Thomas F. Anders, Brown University.

Early analyses of these data were presented at the 4th International Pediatric Sleep Association in Taipei, Taiwan and the 2017 Biennial Meeting of the Society for Research on Child Development in Austin, Texas. Data on the DISCORD measure were first presented in a poster session at the 2012 International Conference on Infant Studies. Further data on the DISCORD was published in the *Journal of Family Psychology* in 2015.

**Keywords**

household chaos; parent sleep; infant sleep; family; self-regulaton

---

Household chaos is a complex construct that has been found to play a central role in shaping individual and relational processes within families and, in turn, children's development (Dumas et al., 2005). Bridgett, Burt, Edwards, and Deater-Deckard (2015), identified household chaos as one manifestation of poor self-regulation in adult heads of households, and that household chaos was an important mediating link between parents' self-regulation and indicators of self-regulation in children. Household chaos theory hypothesizes that an ordered, predictable spatial and auditory environment functions to convey family patterns and beliefs to children and help them discern cause-effect relations between family members. By contrast, a chaotic environment impedes the transmission of patterns and beliefs (Bradley & Caldwell, 1978; Matheny, Wachs, Ludwig, & Phillips, 1995; Wachs & Evans, 2010; Ward, 1995; Weisner, 2010). Together, theory and findings suggest household chaos is key in understanding the interrelationships between individual and family regulatory functioning. Typically defined in terms of the absence of physical and temporal organization in the home, high household chaos is identified by high amounts of household clutter and by the absence of structured, stable routines (Fiese & Winter, 2010; Wachs & Evans, 2010). It is highly stable across time (Deater-Deckard et al., 2009; Whitesell, Teti, Crosby, & Kim, 2015), linked with lower socioeconomic status (SES) and major life events (Deater-Deckard et al., 2009; Evans, Eckenrode, & Marcynyszyn, 2010), and predictive of individual and relational distress (Ackerman & Brown, 2010; Valiente, Lemery-Chalfant, & Reiser, 2007), even when SES is controlled (Wachs & Evans, 2010).

## Regulated Processes of Sleep and Household Chaos

The present study examined linkages between household chaos and infant and parent sleep during the infants first year. Interestingly, no published study to date has examined household chaos as a predictor of sleep in infants and parents during the infants' first year. Much of the work on household chaos and sleep has instead focused on adults (El-Sheikh, Keiley, Bagley, & Chen, 2014) or children in preschool, grade school, or adolescence (Appelhans et al., 2014; Bridgett, Burt, Laake, & Oddi, 2013; Brown & Low, 2008; Ferretti & Bub, 2014; Gregory, Eley, O'Connor, Rijsdijk, & Plomin 2005; Lumeng et al., 2007; Staples, Bates, & Petersen, 2015). In these studies, higher household chaos was generally linked to more child sleep problems, suggesting household chaos would also negatively influence infant sleep during the first year of life. Ferretti and Bub (2014) reported significant linkages between well-regulated and organized bedtime environments (established bedtime routines and regular bedtimes), infant sleep at 14 months, and infant behavioral and emotional regulation among children at 36 months. In addition, Staples et al. (2015) found that regular bedtime activities predicted an increase in the amount of nighttime sleep, whereas inconsistent daytime parenting, a reflection of higher household chaos, predicted decreases in the amount of nighttime sleep in preschoolers. These findings are echoed in other studies of preschoolers (Gregory et al., 2005), 6 to 13 year olds (Appelhans et al., 2014) and 9 to 12 year olds (Lumeng et al., 2007), suggesting that household chaos debilitates self-regulated sleep in children across a wide age range.

In addition to investigating the "main effect" impact of household chaos on infant and parent sleep, we were interested in the manner in which household chaos affected trajectories of sleep development across the first year. Typically developing 1-month-old infants typically sleep in segments of 3 to 4 hours (Middlemiss, 2004), with nighttime sleep cycles showing more sustained and uninterrupted, or consolidated sleep patterns with less fragmentation between 3 and 6 months (El-Sheikh & Sadeh, 2015; Middlemiss, 2004; Sadeh & Anders, 1993). By 8 months of age, infants sleep for 6 to 7 hours at a time and are generally able to self-regulate, or transition themselves from wakefulness to sleep during night awakenings without adult assistance (Middlemiss, 2004; Sadeh & Anders, 1993). Between the ages of birth to 3 years old, sleep is gradually consolidated into a diurnal pattern with a longer nighttime sleep and less need for daytime napping (Sadeh & Anders, 1993; Staples et al., 2015).

However, although the described sleep consolidation is normative, this process does not progress smoothly for many infants, and estimates of infants experiencing significant sleep problems range from 25% - 33% (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006). Sleep development in infancy is determined and impacted by a system of relational and family-level factors (El-Sheikh & Sadeh, 2015; Sadeh, Tikotzky, & Scher, 2010; Staples et al., 2015; Teti & Crosby, 2012). Relational factors include marital adjustment, coparenting quality, and parents' emotional availability with infants (Kretschmer & Pike, 2009; Whitesell et al., 2015) that, when compromised, can impede trajectories of infant sleep regulation. The present study is the first to assess the impact of a family-level factor, household chaos, on infant and parent sleep across the infant's first year.

## The present study

The present study focused on relations between household chaos, assessed through direct observation and interaction with participants, and infant, mother, and father sleep throughout the infant's first year. In doing so, we controlled for proximal relational processes, bedtime parenting quality and marital adjustment, each of which is known to be associated with household chaos (Nelson, O'Brien, Blankson, Calkins, & Keane, 2009; Whitesell et al., 2015) and with infant and adult sleep (Troxel, Buysse, Hall, & Matthews, 2009; Teti, Kim, Mayer, & Countermine, 2010). The present study thus examined linkages between household chaos and infant and parent sleep net of any influences of marital and parenting quality. Analyses examined mean level and nightly variability of nighttime sleep duration and sleep fragmentation across five age points in the infants' first year. The following hypotheses were proposed:

**a.** Based on findings from earlier studies of infant sleep and its consolidation across the early post-partum period (Middlemiss, 2004; Sadeh & Anders, 1993), it was expected that in low chaos homes infants' average nightly sleep duration would be lowest between 3 and 6 months and increase as infants approached 12 months of age. By contrast, infants in high chaos homes were expected to show a slower increase in sleep duration across time compared to infants in high chaos homes.

**b.** Infants' average nightly sleep fragmentation in low chaos homes was expected to be highest in the early months and to decrease as the infant neared 12 months. By contrast, it was expected that infants in more chaotic homes would show slower reduction in sleep fragmentation across the first year, compared to infants in lower chaos homes.

**c.** Because household chaos theory suggests a greater amount of household chaos will affect both level and variability of patterns, it was expected that in higher chaos homes parents would have shorter sleep durations and greater sleep fragmentation, with greater nightly variability in both.

## Methods

### Participants

The present study was fully approved by Institutional Review Board of the Office of Research Protections at the Penn State University, protocol no. PRAMS00042695, "SIESTA (Study of Infants' Emergent Sleep TrAjectories)". Subjects were drawn from the participants in the larger, longitudinal SIESTA study of parenting, infant sleep, and infant development (R01 HD052809), which was funded by the National Institute of Child Health and Human Development (NICHD). Families were recruited from two central Pennsylvania hospitals 24 to 48 hours after delivery of a healthy, full-term, infant. Parents who showed interest in the study while in the hospital were contacted by phone 2 to 3 weeks after birth to receive a complete description of the full study. Interested parents were consented at the first home visit (N = 167), taking place when the infant was approximately 1 month old. Data were collected for the larger study, when infants were 1, 3, 6, 9, 12, 18, and 24 months old. The present study includes only data from the infants' first year. Twenty-three families had dropped from the study by 12 months, and analyses of variance were conducted to compare these families with the 144 who remained in the study. These analyses revealed that study families were representative of the larger sample. No subgroup differences were found in socioeconomic risk, yearly income, parent education, infant gender, or parent age or race. Mothers' rating of space constraints showed significant differences, (mothers in study families reported having less space constraints than mothers in non-study families). Of the variables of focus in this study, only household chaos significantly different in the study and non-study groups, with the non-study groups having significantly higher household chaos.

Eighty-four percent of mothers and 84% of fathers identified themselves as White, with the remaining 12% of mothers and 15% of fathers identifying as non-White. Ninety-five percent of the parents were married or living in the same household. Annual family income ranged from less than $10,000 to $325,000 (M = $69,504, SD = $47,605). Parent education varied, with 13% of mothers and 15% fathers attending high school without further schooling, 27% of mothers and 24% of fathers attending college without completing a bachelor's degree, and 23% of mothers and 30% of fathers graduating with a bachelor's degree, and 37% of mothers and 31% of fathers moving on to a graduate or professional degree (master's degree or higher). Mothers ranged in age from 18 to 43 years old (M = 29.43, SD = 5.27). Fathers ranged in age from 21 to 49 years old (M = 32.10, SD = 5.87). Thirty-seven percent of families had one child in the home, 40% of families had two children in the home, and the remaining 22% had more than two children in residence. Fifty-three percent of the infants in the study were female.

## Procedures

Families were visited in the home when infants were 1, 3, 6, 9, and 12 months old. Data were collected over seven consecutive days at each time point. Project staff had contact with families at three home visits and daily phone contact with each parent during the 7-day period. Home visits lasted between 30 minutes and two hours; observations of household chaos were made throughout each visit and during daily parent phone interviews. At the first visit mothers, fathers, and infants received a Respironics/Mini Mitter Actiwatch (model AW-64) and all parent questionnaires that were to be completed by the 7$^{th}$ day of data collection. Mothers and fathers scheduled a daily phone interview with project staff to obtain information about parents' and infants' sleep and wake times during the previous night and morning. A second visit was scheduled, typically for the 6$^{th}$ day of the data collection week so that video equipment could be staged to collect bedtime and nighttime data for the larger study. The third and final visit was scheduled for the 7$^{th}$ day of the week to collect equipment and parent questionnaires. At the completion of each visit and phone interview, project staff made tentative notes about the physical organization of the home, parents' management of intrusions, availability for daily interviews, and if the visit had to be rescheduled or was delayed because the family was running late. At the completion of the third visit and last parent phone interview, project staff completed the household chaos assessment using notes from all three visits and daily phone interviews for that time point and assessed whether each parent successfully completed their questionnaires.

## Measures

**Sociodemographics—**At 1 month, parents completed a brief questionnaire that comprised parent race, age, marital status, educational attainment, yearly family income, and number of adults and children living in the home.

**Household chaos—**The household chaos assessment used in this study, the Descriptive In-Home Survey of Chaos—Observer ReporteD (DISCORD; Whitesell et al., 2015) was developed and introduced in the second year of the project. The DISCORD was initially constructed to capture the repeated observations of environmental disruptions to family processes and visit protocols. The final measure was based on previous theory and measures of household chaos (Matheny et al., 1995; Wachs & Evans, 2010) and included 11 items that assessed the physical organization of the home, parents' ability to manage disruptions and predict daily routines, and parents' ability to adhere to study protocol. Each item was scored on a 3-point scale with a maximum score of 33, where higher scores indicated greater household chaos.

Internal reliability of the household chaos composite was adequate at all age points (alphas = 79, .71, .75, .80, .83). All home visitors (eight different people across the span of three years) participated in household chaos ratings. Inter-rater reliability [intraclass correlation (ICC), absolute agreement] between rater pairs on this composite was .97, based on 47 home visits. Pearson correlations, conducted to assess the stability of household chaos across the infants' first year of life, revealed high stability, with cross-time correlations ranging from .62 to .81 (all *p*s < .001). This was consistent with earlier work finding strong longitudinal stability in assessments of household chaos in the home (Deater-Deckard et al., 2009; Matheny et al., 1995).

Fifty-one families had household chaos assessed at all five time points, 25 had household chaos assessed at four time points, 24 had household chaos assessed at three time points, 15 had household chaos assessed at two time points, and 26 had household chaos assessed at one time point. Due to the longitudinal stability of the DISCORD, all available chaos assessments were averaged across the first year for each family to provide one household chaos score per family for the full year.

**Sleep-wake activity—**For seven consecutive days at each age point, infants wore a Respironics/Mini Mitter Actiwatch (model AW-64) on their ankle (affixed with a soft elastic band), which provided information about the sleep/wake activity during the night for each of the seven nights. Sampling epoch length for all actiwatches was 1 minute, and a medium (40 activity counts) wake threshold value was used. The Sadeh algorithm (Sadeh, Sharkey, & Carskadon, 1994), which identifies sleep onset as the first of at least 3 continuous minutes of sleep and sleep offset as the last of at least 5 continuous minutes of sleep, was used to identify sleep duration throughout the night. Nighttime sleep was defined using the Sadeh algorithm, and actigraph records were cross-checked against parent diary reports of when the infant was put to bed and fell asleep each night and woke up the following morning. Actiware® (version 5.0) software (Respironics/Mini Mitter, 2005) was used to determine, for each of the seven nights, nighttime sleep duration (total minutes between sleep onset and sleep end) and nighttime sleep fragmentation (percent of mobile bouts + percent of immobile bouts less than 1 minute in duration). The mean and standard deviation of both sleep duration and sleep fragmentation was obtained for the full week of data collection. Pearson *r*s revealed small-to-moderate stability in mean sleep duration (*r*s = .26 to .58 for mothers, .41 to .72 for fathers, and .20 to .54 for infants), mean sleep fragmentation (*r*s = .31 to .61 for mothers, .34 to .64 for fathers, and .26 to .47 for infants), the variance of sleep duration (*r*s = .20 to .40 for mothers, .18 to .38 for fathers, and .18 to .28 for infants), and for fathers only, the variance of sleep fragmentation (*r*s = .20 to .46). Variability in mothers and infants' sleep fragmentation was less stable across time and significantly correlated time points were generally weaker as well (*r*s = .18 to .24 for mothers and .19 for infants).

**Bedtime, sleep onset, and wake times—**Parents completed the 24-Hour Sleep Patterns Interview (24-HSPI) (Meltzer, Mindell, & Levandoski, 2007) by phone for seven consecutive days at each age point, to obtain information on bedtime, sleep and wake times for parents and infants.

**Covariates—**Household chaos is a family-level construct whose effects on sleep may be transmitted in part by "proximal" interpersonal processes that have been empirically associated with household chaos (Wachs & Evans, 2010). Consistent with this perspective, we included maternal emotional availability with infants at bedtime (EA) as a covariate in analyses predicting infant sleep. Maternal EA has been empirical associated with household chaos (Whitesell et al., 2015) and has been identified as a significant predictor of infant sleep quality (Teti et al., 2010). In addition, we included mothers' reports of marital adjustment (MA) as a covariate in analyses predicting parent sleep. MA's links with household chaos (Nelson et al., 2009) and as a predictor of adult sleep (Troxel et al., 2009) are well-established. In addition, in the present study, household chaos was negatively correlated, as expected, with mothers' bedtime emotional availability (EA), $r(121) = -.58$, $p < .001$, and with mothers' reports of marital adjustment, $r(120) = -.31$, $p = .001$.

Mothers' reports of marital adjustment were collected when infants were 1 month and 12 months old, using the Locke-Wallace Marital Adjustment Test (MAT) (Locke & Wallace, 1959), with four additional items (religious matters; aims, goals, and things believed to be important; making major decisions; and household tasks) incorporated from Spanier's (1976) Dyadic Adjustment Scale (DAS). In the present study, internal reliability of the marital adjustment measures was .91 and .90 (standardized item alpha) at 1 and 12 months, the 1 and 12 month measures were highly intercorrelated, $r(136) = .79$, $p < .001$, and thus they were meaned into a single composite MA score per family for use in analyses. Maternal bedtime EA with their infants was assessed from digital video recordings, using multiple camera and audio inputs, at 1, 3, 6, 9, and 12 month, using the well-established and validated Emotional Availability Scales (Biringen, Robinson, & Emde, 1998). The four parent EA scales (5-to-9-point scales), maternal sensitivity, structuring, intrusiveness (reverse-scored) and hostility (reverse-scored) were each scored by two trained, certified EAS coders. These scales were internally reliable at each age point (alpha = .77 to .88), and thus the four EA scales at each age point were standardized and summed to create a composite EA score per family at each age point. These composites were highly stable across infant age ($r$s = .25 to .61) and were thus meaned across age to create a mean composite EA variable per family. Inter-rater reliability on this composite, based on 42 videorecordings that were evenly dispersed across the five infant age points, was adequate (intraclass correlation = .98). The reader is referred to Whitesell et al. (2015) for additional information about video equipment and camera setup.

## Analysis

All models were run using the full sample. To test the hypotheses, mixed multilevel models were fit using a maximum likelihood estimation method that adjusts for missing data to predict each sleep variable for mothers, fathers, and infants. The infant's age in months at the time of measurement was recoded so that the first measurement occasion (1 month) was centered at zero. Subsequent occasions were represented as 2 (3 months), 5 (6 months), 8 (9 months), and 11 (12 months). Household chaos was mean-centered and represents the family's average score of available chaos scores across the first year, and the two covariates were also mean-centered. A two-level model was created to determine if each sleep variable was a function of the linear or quadratic effects of time or household chaos, adjusting for the covariate. The Level 1 equation was represented as:

$$\text{sleepvar}_{ti} = \sigma_{0i} + \sigma_{1i}\,(\text{month-1})_{ti} + \sigma_{2i}\,(\text{month-1})^2_{ti} + \varepsilon_{ti}$$

in which the individual's predicted sleep score for the specified variable at time t (sleepvar$_{ti}$), was a function of an individual's sleep score at time 0 (1 month of age; $\sigma_{0i}$), that individual's monthly linear and quadratic rates of change in that sleep variable [$\sigma_{1i}$ (month-1)$_{ti}$ and $\sigma_{2i}$ (month-1)$^{2}_{ti}$, respectively], and the error associated with that individual after accounting for the linear and quadratic effects of infant age ($\varepsilon_{ti}$).

Level 2 equations were:

$$\sigma_{0i} = b_{00} + b_{01}\,\text{chaosmean}_j + (b_{02}\,\text{covariate}_j) + \mu_{0i}$$
$$\sigma_{1i} = b_{10} + b_{11}\,\text{chaosmean}_j + (b_{12}\,\text{covariate}_j) + \mu_{1i}$$
$$\sigma_{2i} = b_{20} + b_{21}\,\text{chaosmean}_j + (b_{22}\,\text{covariate}_j) + \mu_{2i}$$

In the first equation the individual's sleep score at 1 month of age ($\sigma_{0i}$) was a function of the grand mean for the specified sleep variable ($b_{00}$), the main effect of chaos on the sleep variable ($b_{01}$ chaosmean$_i$) after controlling for the effect of MA in mother/father models or EA in infant models on the sleep variable ($b_{02}$ covariatej$_j$), and the individual deviation from the grand mean after accounting for the main effect of chaos ($\mu_{0i}$). The second and third equations incorporate linear and quadratic change, respectively. Specifically, the individual's linear or quadratic rate of change across the first year in the specified sleep variable ($\sigma_{1i}$; $\sigma_{2i}$) was a function of the average linear or quadratic rate of change in the sleep variable for the full group ($b_{10}$; $b_{20}$), the effect of chaos on the linear or quadratic rate of change ($b_{11;}$ $b_{21}$ chaosmean$_i$) after controlling for the effect of MA in parent models or EA in infant models on the sleep variable ($b_{12}$; $b_{22}$ covariatej$_j$), and the individual deviation from the average linear or quadratic rate of change after accounting for chaos's effects on linear or quadratic change ($\mu_{1i}$; $\mu_{2i}$).

Preliminary unconditional means models were significant for all sleep variables, and intraclass correlations (ICC), reflecting the percentage of between-subject variability in the dependent variables, were quite variable. Between subject variability in sleep variables was lowest for infants (ICC range: .05 for variability in sleep fragmentation to .30 for mean sleep duration, $M = .15$), intermediate for maternal sleep variables (ICC range: .11 for variability in sleep fragmentation to .42 for mean sleep duration, $M = .31$), and highest for paternal sleep variables (ICC range: .28 for variability in sleep duration to .59 for mean sleep duration, $M = .41$). Chi-square deviance tests found that models that included quadratic change accounted for significantly more variance in sleep variables across time than models that included linear change only (all $p$s < .01). Unconditional models identified random intercepts as significant in all but one model, but neither linear nor quadratic change was identified as a random effect in any model. The final, conditional models predicted sleep variables using linear and quadratic effects of infant age, household chaos, interactions of household chaos with linear and quadratic infant age, and MA for parent sleep variables and EA for infant sleep variables as a covariate, all modeled as fixed effects. Significant results from the final models are reported below (See Table 1 for all results). All data points in the Figures 1 through 4 are model-implied, predicted values.

## Results

### Mean Sleep Duration

**Infant sleep duration—**Analyses revealed a significant main effect of household chaos ($b = 3.86$, $SE = 1.58$, $p = .02$), such that infants in higher chaos homes had longer sleep duration than infants in lower chaos homes (see Figure 1). Linear ($b = 13.07$, $SE = 1.87$, $p < .001$) and quadratic ($b = -.76$, $SE = .16$, $p < .001$) change in infant sleep were also significant, and both linear, $b = -1.30$, $SE = .50$, $p = .01$, and quadratic, $b = .10$, $SE = .04$, $p = .03$, chaos X infant age interactions were significant for infants. When these significant, cross-level interactions were probed following guidelines put forth by Preacher, Curran, and Bauer (2006), it was found that simple linear slopes for infant sleep duration were significant when chaos was less than .83 and when chaos was greater than 8.79. Figure 1 illustrates the increasing linear infant sleep duration in lower ($b = 18.23$, $SE = 2.55$, $p < .001$) vs. higher ($b = 7.91$, $SE = 2.87$, $p = .01$) chaos homes. The significant chaos X quadratic change in infant sleep duration interaction is evident in that infants in lower chaos homes saw sleep duration peak at 9 months and then decrease, whereas infants' sleep duration in higher chaos homes continued to increase through 12 months.

**Parent sleep duration—**Analysis of mothers' sleep duration revealed significant linear ($b = -9.12$, $SE = 1.72$, $p < .001$) and quadratic ($b = .51$, $SE = .15$, $p < .01$) change in sleep duration across time, but no main or interactive effects of chaos. Figure 1 showed mothers' sleep decreased across infant age overall. The quadratic change is evidenced by the slowing and uptick in maternal sleep duration between 9 and 12 months. For fathers, only the interaction of chaos by linear infant age ($b = 1.01$, $SE = .46$, $p = .03$) was significant (see Figure 1). Probing this interaction revealed that fathers' sleep duration decreased significantly across infant age in lower chaos families (when chaos $< -1.66$) but did not change significantly across time when family chaos was higher (see Figure 1; Low Chaos, $b = -5.28$, $SE = .1.98$, $p = .01$; High Chaos, $b = 2.68$, $SE = 2.75$, $p = .33$).

### Variability in Sleep Duration

Across all family members, main effects of household chaos were significant (infants, $b = 1.81$, $SE = .63$, $p < .01$; mothers, $b = 2.58$, $SE = .81$, $p < .01$; and fathers, $b = 1.84$, $SE = .88$, $p = .04$) for variability in sleep duration, such that individuals living in higher chaos homes had greater nightly variability in their sleep duration than those living in lower chaos homes (see Figure 2). Additional findings for infants showed significant linear, but not quadratic, decreases in variability in sleep duration ($b = -2.78$, $SE = .94$, $p < .01$) and also an effect of the covariate, bedtime maternal EA, such that higher bedtime EA was predictive of less variability in sleep duration overall ($b = -.28$, $SE = .13$, $p = .03$). Fathers also showed significant linear ($b = -3.19$, $SE = 1.21$, $p = .01$) and quadratic ($b = .22$, $SE = .11$, $p = .04$) effects in nightly variability of sleep duration across age. For mothers, there were no linear or quadratic effects across infant age and none of the interactions between chaos and infant age were significant for any family member.

### Mean Sleep Fragmentation

Main effects of household chaos indicated that mothers, fathers, and infants in higher chaos homes had more fragmented sleep compared to those in lower chaos homes (infants, $b = .63$, $SE = .30$, $p = .04$; mothers, $b = .60$, $SE = .26$, $p = .02$; and fathers, $b = .93$, $SE = .33$, $p = .01$; see Figure 3). All family members were found to have significant linear change, such that, as expected, sleep fragmentation decreased across the first year for infants, $b = −7.88$, $SE = .39$, $p < .001$; mothers, $b = −2.04$, $SE = .30$, $p < .001$; and fathers, $b = −1.01$, $SE = .36$, $p = .01$. Finally, quadratic change was also present and in the expected direction in that sharper decreases were generally evident before 6 months of infant age than after 6 months for all family members (infants, $b = .49$, $SE = .03$, $p < .001$; mothers, $b = .13$, $SE = .03$, $p < .001$; and fathers, $b = .09$, $SE = .03$, $p = .01$). For fathers, the household chaos by linear infant age approached significance, b = −.20, SE = .10, p = .053, and the household chaos X quadratic infant age was significant ($b = −.02$, $SE = .01$, $p = .02$). Analyses of simple slopes and examination of Figure 3 revealed that fathers in families with standardized chaos levels above −1.59, which translates into low-moderate to high levels of chaos, had higher levels of fragmentation in infants' early months of life followed by significant decreases in their sleep fragmentation across age, compared to fathers in lower chaos homes, whose sleep fragmentation remained low and stable across the infants' first year. Further inspection of Figure 3 illustrates the chaos X quadratic change interaction, in that compared to the low and stable sleep fragmentation among fathers in lower chaos homes, sleep fragmentation among fathers in higher chaos homes was initially higher, decreased during the first half of the year and rather than continuing to decrease, increased during the second half of the year.

### Variability in Sleep Fragmentation

Unexpectedly, for mothers and infants, neither the main effects of household chaos nor the chaos by infant age interactions on variability in sleep fragmentation were significant, nor was there any linear or quadratic change in variability of mothers' sleep fragmentation (see Figure 4). Infants did however, show decreasing linear ($b = −.70$, $SE = .15$, $p < .001$) and quadratic change ($b = .05$, $SE = .01$, $p < .001$) in variability in sleep fragmentation over time, in that variability in infant sleep fragmentation decreased significantly across the infants' first year, especially during the first six months of life, after which it leveled off. For fathers, however, a significant main effect of household chaos ($b = .34$, $SE = .13$, $p = .01$) was obtained, such that fathers' variability in sleep fragmentation was higher in high chaos homes than in low chaos homes. In addition, a significant interaction between household chaos X quadratic change in variability in fathers' sleep was obtained ($b = .01$, $SE = .004$, $p = .03$). Analyses of simple slopes and visual inspection of Figure 4 revealed that fathers in moderate-to-high chaos homes (chaos score > 0.50) began the year at high levels of variability in infant sleep fragmentation and showed sharper and significant decreases in sleep fragmentation variability across the year, followed by an uptick in variability between 9 and 12 months. By contrast, fathers in low chaos homes (chaos score < 0.50) began the year at lower levels of variability in sleep fragmentation and did not decrease significantly across the year.

### Post Hoc Analyses

Considering that in the infant's first year, the parameters of nighttime sleep are in part established by parents, a post-hoc analysis of linkages between household chaos and parent-reported infant and parent sleep and wake times was conducted. Partial correlations controlling for EA in infant analyses and MA in parent analyses, examined relations between household chaos and individuals' sleep start and sleep end times. At 1, 3, 6, and 9 months of age, household chaos was positively associated with later infant bedtimes (partial *r*s = .18 to .19, all *p*s < .05). At all time points, household chaos was positively associated with later reported sleep onset times for mothers, partial *r*s = .30 to 41, all *p*s < .01; and for fathers partial *r*s = .20 to .29, *p*s < .05. Reported sleep onset times also tended to have greater variability across the week in higher chaos homes for all family members (infants at 3, 6, and 9 months, partial *r*s = .19 to, 32 all *p*s < .05; mothers at 1, 6, 9, and 12 months, partial *r*s = .22 to .36, all *p*s < .02; and fathers at 1, 3, 6, and 12 months, partial *r*s = .23 to .28, *p*s < .02).

The relationships between household chaos and average wake up times for parents and infants was less consistent compared to bedtimes and sleep start times. Infants' average reported wake up times were positively associated with household chaos at 9 (partial $r = .21$, $p = .02$) and 12 months (partial $r = .18$, $p = .05$), such that infants in higher chaos homes woke up later than infants in low chaos homes. Similarly, household chaos and mothers' average reported wake up time were positively correlated at two timepoints, at 6 (partial $r = .33$, $p = .001$) and 9 months (partial $r = .25$, $p = .01$). At no timepoint were fathers' average reported wake up times correlated with household chaos. However, variability in parents' reported wake up time was much more consistently related to household chaos. Mothers (partial *r*s = .19 to .25, *p*s < .05) and fathers' (partial *r*s = .26 to .35, *p*s < .01) variability in wake up times were positively linked to household chaos at all timepoints. At all but 1 and 9 month timepoints, infant wake up times were also much more variable in higher chaos homes (partial *r*s = .20 to .33, *p*s < .03).

## Discussion

In the present study, we examined the relationships of household chaos and infant and parent sleep across the infants' first year. In the main, hypotheses were supported. Consistent with prior work demonstrating increasing sleep consolidation among infants in the first year (El-Sheikh & Sadeh, 2015; Middlemiss, 2004; Sadeh & Anders, 1993), infants' sleep duration increased as fragmentation decreased from 1 to 12 months for all infants. Unexpectedly, sleep among infants in higher chaos homes was of significantly higher duration than the sleep of infants in low chaos homes. In addition, significant chaos X linear and quadratic change interactions were obtained such that developmental trajectories of sleep duration among infants in higher chaos homes were longer and less steeply sloped than infants in lower chaos homes. Longer durations of sleep for these infants was unanticipated; however, with more fragmented sleep and more variable bedtimes and wake ups, infants in higher chaos homes may need more nighttime sleep to compensate for poorer quality sleep. In addition, parents in lower chaos homes may be aiding their infants' more efficient sleep consolidation by maintaining better, and more regular, sleep hygiene practices for both themselves and their infant. As previous studies have shown, parents in lower chaos homes have better limit setting practices and greater emotional availability during sleep routines, which aid in creating an environment that encourages better sleep quality (Sadeh & Anders, 1993; Sadeh et al., 2010; Whitesell et al., 2015). The post-hoc analyses, showing later and more variable sleep onset times, could be a reflecting a combination of having few and/or variable bedtime practices in addition to being less able to set and maintain limits. Collectively, these findings suggest that infants in lower chaos homes may be "learning" to self-regulate sleep with less difficulty than infants in higher chaos homes (Sadeh & Anders, 1993; Staples et al., 2015).

A persistent finding for both parents is the destabilizing effect of chaos, found in both actigraph and parent reported data. Among parents, fathers' sleep was most sensitive to high household chaos, with increases in sleep duration and fragmentation across the infants' first year pushing against assumptions of parents getting increasingly better sleep as infant sleep matures. Opposing patterns in low and high chaos homes for fathers' sleep suggest that, at the extremes of the household chaos spectrum, fathers are experiencing vastly different sleep patterns across infants' first year. Though household chaos is less predictive of mothers' improving sleep over time, mothers in higher chaos homes are experiencing more variable sleep duration and greater fragmentation, which doubtless, intensifies other stressors and reduces mothers' self-regulating ability.

Infant sleep consolidation is, of course, a much longer process than what can be shown in the current data (Sadeh & Anders, 1993; Staples et al., 2015). It is possible that if data were examined from the infants' second and third years, infants in higher chaos homes could reach a similar, more efficient diurnal pattern of nighttime sleep as infants in lower chaos homes appeared to have achieved in a shorter period. However, early sleep patterns have been found to stabilize after the infant's first year (Scher, Epstein, & Tirosh, 2004), and infant sleep patterns in higher chaos homes, which are guided by their caregivers' regulatory abilities (Bernier, Carlson, & Whipple, 2010; Bridgett et al., 2013; El-Sheikh & Sadeh, 2015; Sadeh et al., 2010; Staples et al., 2015), may be laying the groundwork for further sleep and other regulatory difficulties. Ineffective regulatory abilities in parents can easily lead to a compounded and cascading effect in which dysregulated parents adapt poorly to their children's changing sleep patterns (Bridgett et al., 2013; Gregory et al., 2005; Jocson & McLoyd, 2015) and therefore, parents and infants get consistently poorer sleep. This would be expected to further reduce parents' ability to self-regulate and set developmentally appropriate limits for their infants in day and nighttime activities (Sadeh & Anders, 1993; Sadeh et al., 2010). This perpetuating pattern of creating and sustaining patterns of poor sleep and poor self-regulation may reverberate throughout the family system, be difficult to reverse, and may explain the high temporal stability of household chaos found in the present and in previous studies of household chaos (Deater-Deckard et al., 2009; Matheny et al., 1995; Whitesell et al., 2015).

## Limitations

The present study has several limitations. First, this study would have benefited from prenatal assessments of household chaos and sleep, which would enable a determination of the unique impact of transitioning to parenthood on household chaos. Second, maximum likelihood analyses would have benefited from a larger sample size and, although attrition was expected to be greater for high chaos participants due to poorer ability to incorporate study participation into daily life, the significant difference in household chaos between the final sample and those who did not complete the study was another sample limitation. Third, although we believe that the DISCORD, as a new measure of household chaos that is solely reliant on observation, has much to recommend it, including other established measures of household chaos in the present study would have provided an opportunity to compare the DISCORD with other chaos measures and with the family sleep data. Finally, the use of solely objective measures of sleep may not have captured the full impact of household chaos on family sleep, in particular self-report measures of sleep quality that incorporate parental mood. Future studies should consider the potential gain from using both objective measures of sleep as well as parent reported subjective measures.

### Application and Future Direction

Overall, the goal of this study was to examine relations between household chaos and family sleep across the infants' first year. It was expected and found that family members living in high chaos homes experience poorer sleep than family members in low chaos homes. The ability to create and maintain predictable routines that adapt to changing developmental needs while simultaneously managing individual and group needs within the routines may be the key to reducing household chaos. However, regulating routines, particularly those that impact sleep, may be deeply embedded in parents' behavioral and emotional repertoires and may require intervention approaches that begin before the birth of a new infant. Interventions focusing on improving bedtime routines, promoting more consistent infant bedtimes and wake times, and better regulation of parents' own sleep, would significantly predict how successful parents would be in promoting self-regulated sleep in their infants.

### Conclusion

As this study has shown, household chaos significantly disrupts infant and parent sleep in the first year post-partum, both in terms of sleep quality as well as nightly variability in sleep quality, and this impact was observed after statistically controlling for proximal interactional processes known to be linked with household chaos and sleep quality. Though still relatively new to the field, household chaos as a construct has a clear link with regulatory systems that impact daily functioning and well-being. Understanding the mechanisms by which household chaos impacts sleep and other regulatory systems can inform prevention and intervention efforts aimed at improving parent and child self-regulation in chaotic environments.

## Acknowledgments

This research was supported by a grant from the National Institute of Child Health and Human Development (R01HD052809), awarded to the fifth author.

## References

Ackerman BP, Brown ED. Physical and psychosocial turmoil in the home and cognitive development. In: Wachs TD, Evans GW, editorsChaos and its influence on children's development, an ecological perspective. Washington DC: American Psychological Association; 2010. 35–48.

Appelhans BM, Fitzpatrick SL, Li H, Cail V, Waring ME, Schneider KL, Whited MC, Busch AM, Pagoto SL. The home environment and childhood obesity in low-income households: indirect effects via sleep duration and screen time. BMC Public Health. 2014; 14(1):1160.doi: 10.1186/1471-2458-14-1160 [PubMed: 25381553]

Bernier A, Carlson SM, Whipple N. From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. Child Development. 2010; 81(1):326–339. DOI: 10.1111/j.1467-8624.2009.01397.x [PubMed: 20331670]

Biringen Z, Robinson J, Emde RN. Emotional availability scales. 3. Fort Collins: Department of Human Development and Family Studies, Colorado State University; 1998.

Bradley RH, Caldwell BM. Screening the environment. American Journal of Orthopsychiatry. 1978; 48(1):114–130. DOI: 10.1111/j.1939-0025.1978.tb01293.x [PubMed: 146434]

Bridgett DJ, Burt NM, Edwards ES, Deater-Deckard K. Intergenerational transmission of self-regulation: A multidisciplinary review and integrative conceptual framework. Psychological Bulletin. 2015; 141(3):602–654. DOI: 10.1037/a0038662 [PubMed: 25938878]

Bridgett DJ, Burt NM, Laake LM, Oddi KB. Maternal self-regulation, relationship adjustment, and home chaos: Contributions to infant negative emotionality. Infant Behavior and Development. 2013; 36(4):534–547. DOI: 10.1016/j.infbeh.2013.04.004 [PubMed: 23748168]

Brown ED, Low CM. Chaotic living conditions and sleep problems associated with children's responses to academic challenge. Journal of Family Psychology. 2008; 22(6):920–923. DOI: 10.1037/a0013652 [PubMed: 19102613]

Deater-Deckard K, Mullineaux PY, Beekman C, Petrill SA, Schatschneider C, Thompson LA. Conduct problems, IQ, and household chaos: A longitudinal multi-informant study. Journal of Child Psychology and Psychiatry. 2009; 50(10):1301–1308. DOI: 10.1111/j.1469-7610.2009.02108.x [PubMed: 19527431]

Dumas JE, Nissley J, Nordstrom A, Phillips Smith E, Prinz RJ, Levine DW. Home chaos: Sociodemographic, parenting, interactional, and child correlates. Journal of Clinical Child and Adolescent Psychology. 2005; 34(1):93–104. DOI: 10.1207/s15374424jccp3401_9 [PubMed: 15677284]

El-Sheikh M, Keiley M, Bagley EJ, Chen E. Socioeconomic adversity and women's sleep: Stress and chaos as mediators. Behavioral Sleep Medicine. 2014; :1–18. ahead-of-print. DOI: 10.1080/15402002.2014.940110 [PubMed: 23390921]

El-Sheikh M, Sadeh A. I. Sleep and development: Introduction to the monograph. Monographs of the Society for Research in Child Development. 2015; 80(1):1–14. DOI: 10.1111/mono.12141

Evans GW, Eckenrode J, Marcynyszyn L. Poverty and chaos. Chaos and its influence on children's development, an ecological perspective. 2010:225–238.

Ferretti LK, Bub KL. The influence of family routines on the resilience of low-income preschoolers. Journal of Applied Developmental Psychology. 2014; 35(3):168–180. DOI: 10.1016/j.appdev. 2014.03.003

Fiese BH, Winter MA. The dynamics of family chaos and its relation to children's socioemotional well-being. In: Evans G, Wachs T, editorsChaos and its influence on children's development, an ecological perspective. Washington, DC: American Psychological Association; 2010. 49–66.

Gregory AM, Eley TC, O'Connor TG, Rijsdijk FV, Plomin R. Family influences on the association between sleep problems and anxiety in a large sample of pre-school aged twins. Personality and Individual Differences. 2005; 39(8):1337–1348. DOI: 10.1016/j.paid.2005.06.008

Jocson RM, McLoyd VC. Neighborhood and housing disorder, parenting, and youth adjustment in low-income urban families. American Journal of Community Psychology. 2015; 55(3–4):304–313. DOI: 10.1007/s10464-015-9710-6 [PubMed: 25753403]

Kretschmer T, Pike A. Young children's sibling relationship quality: Distal and proximal correlates. Journal of Child Psychology and Psychiatry. 2009; 50(5):581–589. DOI: 10.1111/j.1469-7610.2008.02016.x [PubMed: 19236529]

Locke HJ, Wallace EM. Short marital adjustment and prediction tests: Their reliability and validity. Marriage and Family Living. 1959; 21:251–255.

Lumeng JC, Somashekar D, Appugliese D, Kaciroti N, Corwyn RF, Bradley RH. Shorter sleep duration is associated with increased risk for being overweight at ages 9 to 12 years. Pediatrics. 2007; 120(5):1020–1029. DOI: 10.1016/s0084-3954(08)79183-8 [PubMed: 17974739]

Matheny AP, Wachs TD, Ludwig JL, Phillips K. Bringing order out of chaos: Psychometric characteristics of the confusion, hubbub, and order scale. Journal of Applied Developmental Psychology. 1995; 16(3):429–444. DOI: 10.1016/0193-3973(95)90028-4

Meltzer LJ, Mindell JA, Levandoski LJ. The 24-Hour Sleep Patterns Interview: A pilot study of validity and feasibility. Behavioral Sleep Medicine. 2007; 5(4):297–310. [PubMed: 17937584]

Middlemiss W. Infant sleep: A review of normative and problematic sleep and interventions. Early Child Development and Care. 2004; 174(1):99–122. DOI: 10.1080/0300443032000153516

Mindell JA, Kuhn B, Lewin DS, Meltzer LJ, Sadeh A. Behavioral treatment of bedtime problems and night waking in infants and young children. Sleep. 2006; 29(10):1263–1276. [PubMed: 17068979]

Nelson JA, O'Brien M, Blankson AN, Calkins SD, Keane SP. Family stress and parental responses to children's negative emotions: Tests of the spillover, crossover, and compensatory hypotheses. Journal of Family Psychology. 2009; 23(5):671–679. DOI: 10.1037/a0015977 [PubMed: 19803603]

Preacher KJ, Curran PJ, Bauer DJ. Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. Journal of Educational and Behavioral Statistics. 2006; 31:437–448.

Sadeh A, Anders TF. Infant sleep problems: Origins, assessment, interventions. Infant Mental Health Journal. 1993; 14(1):17–34. DOI: 10.1002/1097-0355(199321)14:1%3C17::aid-imhj2280140103%3E3.0.co;2-q

Sadeh A, Sharkey KM, Carskadon MA. Activity-Based Sleep—Wake Identification: An Empirical Test of Methodological Issues. Sleep. 1994; 17(3):201–207. DOI: 10.1093/sleep/17.3.201 [PubMed: 7939118]

Sadeh A, Tikotzky L, Scher A. Parenting and infant sleep. Sleep Medicine Reviews. 2010; 14(2):89–96. DOI: 10.1016/j.smrv.2009.05.003 [PubMed: 19631566]

Scher A, Epstein R, Tirosh E. Stability and changes in sleep regulation: A longitudinal study from 3 months to 3 years. International Journal of Behavioral Development. 2004; 28(3):268–274. DOI: 10.1080/01650250344000505

Spanier GB. Measuring dyadic adjustment: New scales for assessing the quality of marriage and similar dyads. Journal of Marriage and the Family. 1976:15–28.

Staples AD, Bates JE, Petersen IT. IX. Bedtime routines in early childhood: Prevalence, consistency, and associations with nighttime sleep. Monographs of the Society for Research in Child Development. 2015; 80(1):141–159. DOI: 10.1111/mono.12149 [PubMed: 25704740]

Teti DM, Crosby B. Maternal depressive symptoms, dysfunctional cognitions, and infant night waking: The role of maternal nighttime behavior. Child Development. 2012; 83(3):939–953. DOI: 10.1111/j.1467-8624.2012.01760.x [PubMed: 22506917]

Teti DM, Kim BR, Mayer G, Countermine M. Maternal emotional availability at bedtime predicts infant sleep quality. Journal of Family Psychology. 2010; 24(3):307–315. DOI: 10.1037/a0019306 [PubMed: 20545404]

Troxel WM, Buysse DJ, Hall M, Matthews KA. Marital happiness and sleep disturbances in a multi-ethnic sample of middle-aged women. Behavioral Sleep Medicine. 2009; 7(1):2–19. DOI: 10.1080/15402000802577736 [PubMed: 19116797]

Valiente C, Lemery-Chalfant K, Reiser M. Pathways to problem behaviors: Chaotic homes, parent and child effortful control, and parenting. Social Development. 2007; 16(2):249–267. DOI: 10.1111/j.1467-9507.2007.00383.x

Wachs TD, Evans GW. Chaos in context. In: Evans G, Wachs T, editorsChaos and its influence on children's development, an ecological perspective. Washington, DC: American Psychological Association; 2010. 3–13.

Ward M. Butterflies and bifurcations: Can chaos theory contribute to our understanding of family systems? Journal of Marriage and Family. 1995; 57(3):629–638. DOI: 10.2307/353918

Weisner TS. Well-being, chaos, and culture: Sustaining a meaningful daily routine. In: Evans G, Wachs T, editorsChaos and its influence on children's development, an ecological perspective. Washington, DC: American Psychological Association; 2010. 221–224.

Whitesell CJ, Teti DM, Crosby B, Kim BR. Household chaos, sociodemographic risk, coparenting, and parent-infant relations during infants' first year. Journal of Family Psychology. 2015; 29(2):211–220. DOI: 10.1037/fam0000063 [PubMed: 25705790]

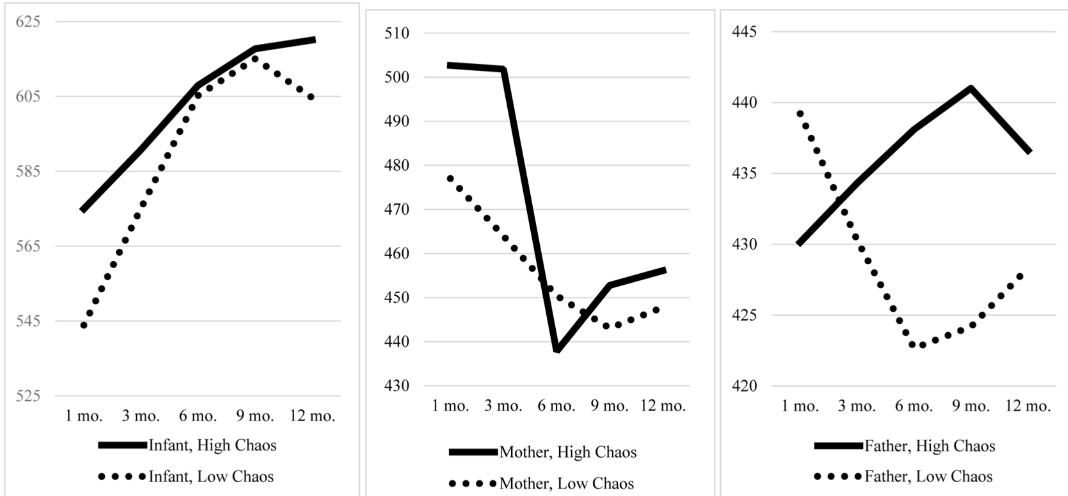


**Figure 1.**
Sleep duration in high (+1SD) vs. low (−1SD) chaos homes, controlling for MA (Mothers and Fathers) or EA (Infants)

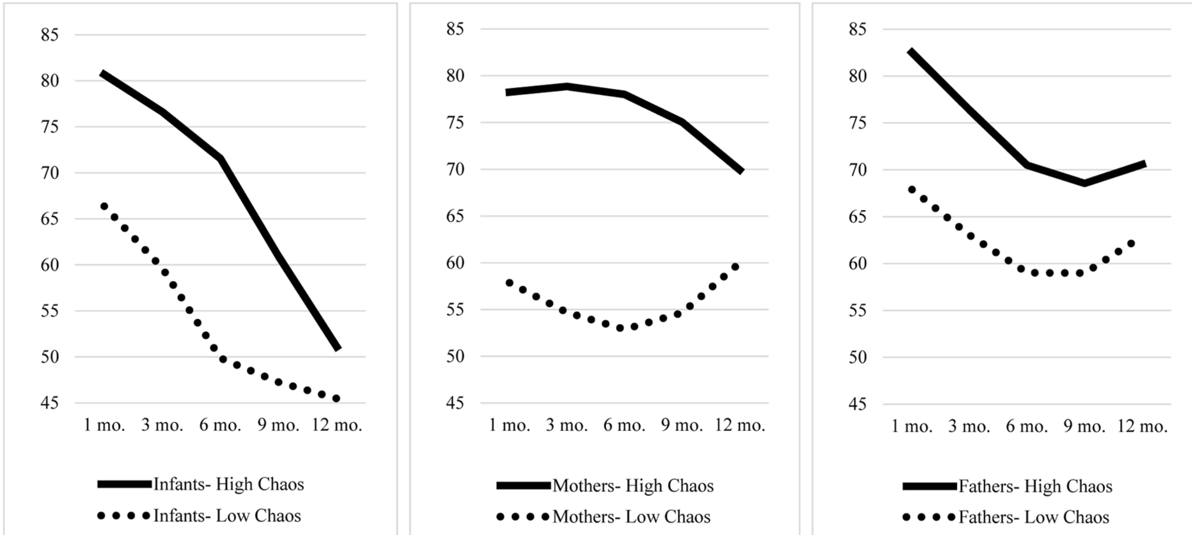


**Figure 2.**

Variability in sleep duration in high (+1SD) vs. low (−1SD) chaos homes, controlling for MA (Mothers and Fathers) or EA (Infants)

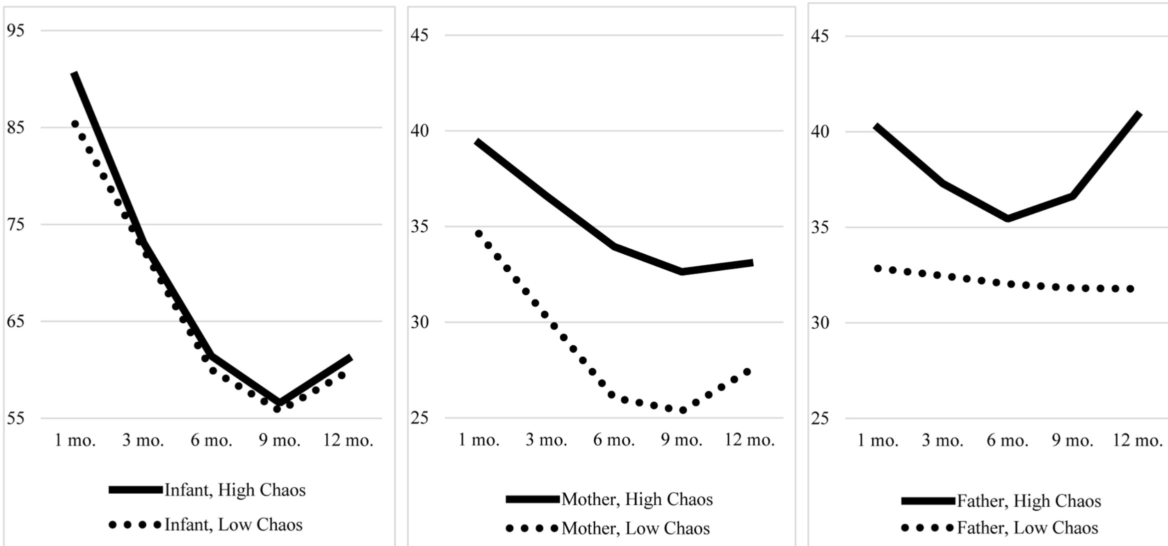


**Figure 3.**
Sleep fragmentation in high (+1SD) vs. low (−1SD) chaos homes, MA (Mother and Father) or EA (Infant)

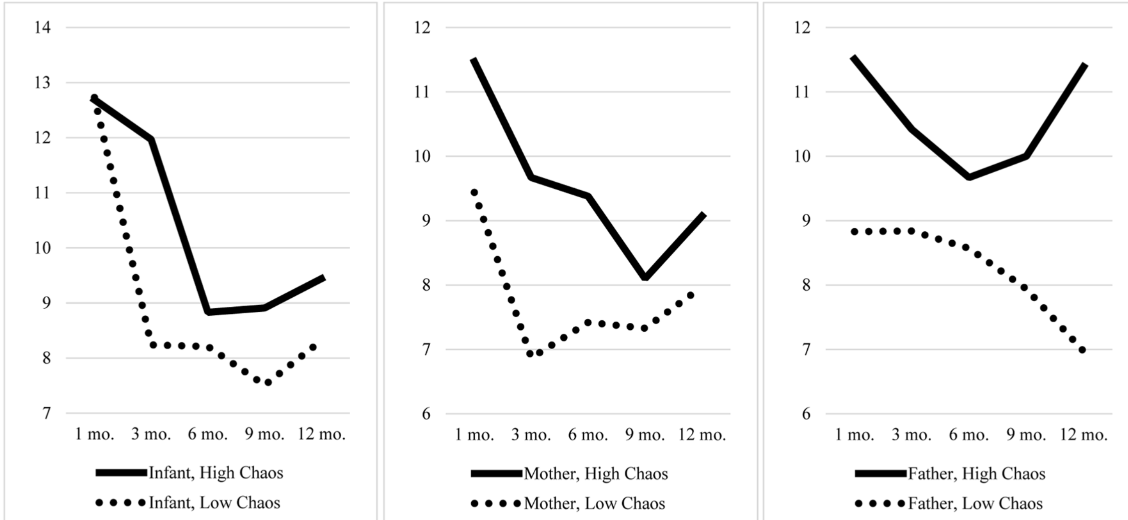


**Figure 4.**

Variability in sleep fragmentation in high (+1SD) vs. low (−1SD) chaos homes, controlling for MA (Mother and Father) or EA (Infant)

## Table 1

Estimates of fixed and random effects predicting sleep variables from linear and quadratic change over time, household chaos, and MA or EA (N = 167, in minutes)

| Predictor Variables | Average Nightly Sleep Duration | | | Variability in Nightly Sleep Duration | | | Average Nightly Sleep Fragmentation | | | Variability in Nightly Sleep Fragmentation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Infant | Mother | Father | Infant | Mother | Father | Infant | Mother | Father | Infant | Mother | Father |
| Fixed effects (coefficients) | | | | | | | | | | | | |
| Intercept | **559.98***** (5.29) | **492.01***** (5.04) | **434.70***** (5.21) | **73.54***** (2.19) | **68.05***** (2.78) | **75.21***** (2.99) | **87.86***** (1.03) | **37.00***** (0.88) | **36.54***** (1.12) | **11.10***** (0.33) | **9.39***** (0.34) | **10.17***** (0.45) |
| Linear Change | **13.07***** (1.87) | **−9.12***** (1.72) | −1.30 (1.57) | **−2.78**** (.94) | −0.72 (1.08) | **−3.19**** (1.21) | **−7.88***** (0.39) | **−2.04***** (0.30) | **−1.01**** (0.36) | **−0.70***** (0.15) | −0.18 (0.15) | **−0.31+** (0.17) |
| Quadratic Change | **−.76***** (.16) | **0.51**** (0.15) | 0.09 (0.14) | .05 (.08) | 0.04 (0.10) | **0.22*** (0.11) | **0.49***** (0.03) | **0.13***** (0.03) | **0.09**** (0.03) | **0.05***** (0.01) | 0.01 (0.01) | 0.02 (0.02) |
| Predictors (coefficients) | | | | | | | | | | | | |
| Household Chaos | **3.86*** (1.58) | 0.33 (1.47) | −1.12 (1.56) | **1.81**** (.63) | **2.58**** (0.81) | **1.84*** (0.88) | **0.63*** (0.30) | **0.60*** (0.26) | **0.93**** (0.33) | 0.15 (0.10) | 0.07 (0.10) | **0.34*** (0.13) |
| Linear Change x Chaos | **−1.31**** (.50) | −0.38 (0.50) | **1.01*** (0.46) | .23 (.25) | 0.32 (0.31) | −0.08 (0.35) | −0.13 (0.10) | 0.12 (0.09) | **−0.20+** (0.10) | −0.03 (0.04) | 0.05 (0.04) | **−0.09+** (0.05) |
| Quadratic Change x Chaos | **.10*** (.04) | 0.001 (0.04) | **−0.08+** (0.04) | −.03 (.02) | −0.04 (0.03) | 0.0001 (0.03) | 0.01 (0.01) | **−0.01+** (0.01) | **0.02*** (0.01) | 0.001 (0.003) | −0.004 (0.004) | **0.01*** (0.004) |
| Controls (coefficients) | | | | | | | | | | | | |
| Marital Adjustment | | −0.27 (0.27) | 0.05 (0.30) | | 0.19 (0.13) | −0.17 (0.14) | | −0.03 (0.05) | −0.01 (0.06) | | −0.01 (0.01) | 0.004 (0.02) |
| Maternal EA at Bedtime | .53 (.39) | | | **−.28*** (.13) | | | −0.01 (0.07) | | | −0.02 (0.02) | | |
| Random effects (coefficients) | | | | | | | | | | | | |
| Intercept | **1411.36***** (248.62) | **1202.06***** (218.13) | **1512.94***** (252.04) | **79.68**** (38.92) | **240.30***** (52.56) | **213.87***** (53.52) | **43.44***** (8.4) | **38.27***** (6.84) | **63.21***** (10.88) | 0.69 (0.56) | **1.47*** (0.62) | **6.63***** (1.44) |
| Model Fit Statistics (−2 Log Likelihood, AIC) | | | | | | | | | | | | |
| Unconditional Quadratic Growth Model | 7714.81<br>7734.81 | 7484.00<br>7504.00 | 6621.57<br>6641.57 | 6629.02<br>6649.02 | 6801.39<br>6821.39 | 6681.73<br>6701.73 | 5458.06<br>5478.06 | 5035.28<br>5055.28 | 5043.63<br>5063.63 | 4611.03<br>4631.03 | 3907.73<br>3927.73 | 3879.04<br>3879.04 |
| Final Conditional Model | 6098.15<br>6116.15 | 5158.02<br>5176.02 | 5048.50<br>5066.50 | 5212.06<br>5230.06 | 4656.01<br>4674.01 | 4690.90<br>4708.90 | 4300.19<br>4318.19 | 3441.67<br>3459.67 | 3590.18<br>3608.18 | 3121.16<br>3139.16 | 2659.57<br>2677.57 | 2822.01<br>2840.01 |

Note: Standard Errors are in parentheses,

+ p < .10,

* p < .05,

** p < .01,

*** p < .001.

Marital adjustment was used as a covariate in analyses of parent sleep. Maternal EA at bedtime was used as a covariate in analyses of infant sleep.