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# The family context of toddler sleep: Routines, sleep environment, and emotional security induction in the hour before bedtime

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## Abstract

Family processes during the pre-bedtime period likely have a crucial influence on toddler sleep, but relatively little previous research has focused on family process in this context. The current study examined several aspects of family process during the pre-bedtime period, including the use of bedtime routines, the qualities of the child's home sleep environment, and the promotion of child emotional security, in families of 30-month-old toddlers (*N*=546; 265 female) who were part of a multi-site longitudinal study of toddler development. These characteristics were quantified using a combination of parent- and observer-reports and examined in association with child sleep using correlation and multiple regression. Child sleep was assessed using actigraphy to measure sleep duration, timing, variability, activity, and latency. Bedtime routines were examined using parents' daily records. Home sleep environment and emotional security induction were quantified based on observer ratings and in-home observation notes, respectively. All three measures of pre-bedtime context (i.e., bedtime routine inconsistency, poor quality sleep environments, and emotional security induction) were correlated with various aspects of child sleep (significant correlations: .11-.22). The most robust associations occurred between the pre-bedtime context measures and sleep timing (i.e., the timing of the child's sleep schedule) and variability (i.e., night to night variability in sleep timing and duration). Pre-bedtime variables, including bedtime routine consistency, home sleep environment quality, and positive emotional security induction,

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[1]Given the large range of nights children could have worn the actigraphs and that wearing the actigraphs for more days may be associated with differences in measured sleep parameters (e.g., sleep variability), we conducted our analyses in two ways. First, we included all subjects who had more than 4 nights of data. Second, we only included subjects with 4 – 15 nights of data. The pattern of results remained the same across these two approaches, so we opted to retain all of the children in the sample.

also mediated the association between family socioeconomic status and child sleep. Our findings underscore the value of considering family context when examining individual differences in child sleep.

**Keywords**

Sleep; Early Childhood; Family Processes; Pre-bedtime Context; Bedtime Routines

A forum of leading child sleep researchers recently identified the need for more research focused on "child sleep and family processes," including how family functioning, parent-child interactions, parental warmth, and child comfort around bedtime influence child sleep (El-Sheikh & Buckhalt, 2015). While the entire context of a child's home environment affects sleep, the pre-bedtime period—the hour or two leading up to bedtime—likely has the most proximal influence on sleep. The interactions, activities, sleep environment, and emotional climate of the pre-bedtime period create the context for a child's transition to sleep, and we hypothesize that the pre-bedtime context, in turn, facilitates or hinders a child's ability to initiate and maintain sleep.

Many families experience difficulties during the pre-bedtime period, with 42% of parents of young children reporting child bedtime resistance (Johnson, 1991). Behavioral sleep interventions, which commonly recommend the implementation of consistent bedtime routines comprised of warm parent-child interactions and soothing activities (Meltzer & Crabtree, 2015; Mindell & Owens, 2015), have been found to reduce child bedtime resistance and other sleep problems (Freeman, 2006; Mindell & Williamson, 2018; Moore et al., 2007). However, little empirical research has examined how differences in existing family processes during the pre-bedtime period are associated with differences in child sleep. The current study considers the association between pre-bedtime context and objectively-measured child sleep, by considering bedtime routines, the quality of the child's home sleep environment, and family interactions that promote emotional security before bedtime in families with young children.

Early childhood is notable for changes in normative sleep patterns, including decreases in daytime sleep (Acebo et al., 2005), decreases in night awakenings (Gaylor, Burnham, Goodlin-Jones, & Anders, 2005), and decreases in the total amount of sleep (Galland et al., 2012). Early childhood is an important developmental window for considering individual differences in child sleep and how family processes affect these individual differences in sleep. Parent involvement in the sleep routine is especially important during this developmental era, as young children usually do not autonomously put themselves to bed. Below, we highlight previous studies that have considered associations between early childhood sleep and aspects of pre-bedtime context.

## Bedtime Routines and Child Sleep

The pre-bedtime period often includes a bedtime routine, defined as the observable, repeated activities enacted with predictable regularity leading up to bedtime (Henderson & Jordan, 2009). Previous research on the pre-bedtime period has often focused specifically on bedtime routines, examining the kinds of activities included in the bedtime routine as well as the consistency of the bedtime routine across nights. Experimental evidence suggests that implementing a nightly bedtime routine is associated with improvements in subjectively-measured (i.e., parent-reported) child sleep in both infants and toddlers, including decreased latency to fall asleep, decreased night awakenings, and increased sleep consolidation (Mindell, Telofski, Wiegand, & Kurtz, 2009). This is strong evidence of the benefit of a nightly bedtime routine. However, substantially less is known about the specific aspects of bedtime routines, or the family processes involved in these routines, that are the most beneficial for sleep.

Research suggests that a higher level of night-to-night adherence to an established bedtime routine in early childhood is associated with longer parent-reported child sleep durations, both concurrently (Mindell, Meltzer, Carskadon, & Chervin, 2009; Mindell & Williamson, 2018; Prokasky, Fritz, Molfese, & Bates, 2019) and longitudinally (across 6-month intervals; Staples, Bates, & Petersen, 2015). Regular bedtime routines appear to have a dose-dependent association with sleep in children from infancy to age 5, such that the number of nights a bedtime routine is implemented per week is linearly associated with parent-reported duration and quality of child sleep (Mindell et al., 2015). Prokasky et al. (2019) found that parent reports of the extent to which families deviated from their normal bedtime routine each night predicted shorter parent-reported sleep durations in toddlers, but not shorter actigraphically-measured sleep durations. Other research has focused on the specific contents of bedtime routines by examining individual steps or activities. This research has shown that certain activities, such as reading stories, may be associated with less bedtime resistance and longer parent-reported nighttime sleep durations in preschoolers (Brown, Rhee, & Gahagan, 2015; Hale Berger, LeBourgeois, & Brooks-Gunn, 2011). Other activities, such as media use during the evening hours, tend to be associated with increased parent-reported sleep problems in early childhood (Garrison, Liekweg, & Christakis, 2011).

## Home Sleep Environment and Child Sleep

The National Sleep Foundation recommends that children’s sleep spaces be comfortable and free from light and noise (National Sleep Foundation, 2020). Previous research suggests that that poor-quality sleep environments, as reported by parents and children, are associated with worse sleep (e.g., Bagley et al., 2015; Billows et al., 2009). Sleep spaces that are crowded (Bagley et al., 2015; Milan, Snow, & Belay, 2007; Rona, Li, Gulliford, & Chinn, 1998), noisy (Bagley et al., 2015; Kahn et al., 1989), disorganized (Billows et al., 2009), overly bright (Kahn et al., 1989), or uncomfortable (Bagley et al., 2015) are associated with worse child sleep. The well-established association between child sleep and socioeconomic status (SES; McDonald et al., 2014; Rona et al., 1998; Tomfohr-Madsen et al., 2020) has been shown to be mediated by poor quality sleep environments in both school-aged children and adolescents (Bagley et al., 2015; Doane et al., 2019), highlighting the importance of the sleep environment.

## Emotional Security and Child Sleep

Sleep and vigilance are conceptualized as opponent processes: the successful initiation of sleep requires the down-regulation of vigilance to the surrounding environment (Dahl, 1996; Dahl & El-Sheikh, 2007). In the present study, we consider variations in family sleep processes that could be related to the facilitation or hindrance of vigilance down-regulation and sleep. To examine family sleep processes that facilitate vigilance down-regulation, previous research has considered positive parenting practices, including emotional availability, warmth, and sensitivity, which may facilitate feelings of emotional security during the pre-bedtime period. Positive parenting practices, characterized by warmth, sensitivity, responsivity, involvement, and positive co-parenting, have been associated with higher quality and quantity of child sleep and fewer sleep problems (Adam, Snell, & Pendry, 2007; Bell & Belsky, 2008; Dubois-Comtois et al., 2019; Spilsbury et al., 2005; Teti, Kim, Mayer, & Countermaine, 2010). In contrast, low parental sensitivity, high parent-child conflict, and low parent-child closeness have been associated with child sleep problems that worsen from third to sixth grade (Bell & Belsky, 2008). These studies support the theoretical proposition that parents who are emotionally available, warm, sensitive, and supportive during the pre-bedtime period facilitate their child's down-regulation of vigilance, thereby promoting the ability to settle to sleep. However, relatively few of the studies of parenting and child sleep have included objective measures of sleep, and only Teti et al. (2010) measured parenting practices specifically in the pre-bedtime context. Including additional objective measures of sleep and specifically focusing on parent-child interactions in the pre-bedtime context will be an important extension of this literature on family sleep processes.

Supportive, positive, and emotionally available parenting may facilitate the down-regulation of vigilance through promoting a child's sense of emotional security. Emotional security refers to the extent to which children perceive their family situation as positive and stable, and caregivers as likely to remain responsive to their needs, despite any family conflict or stress (Davies & Cummings, 1994). Emotional security is thought to influence the ways in which children interact with their environment. Children with low levels of emotional security tend to show high levels of emotional dysregulation (Cummings, Schermerhorn, Davies, Goeke-Morey, & Cummings, 2006), and may be especially prone to psychophysiological arousal in the face of exposure to stress (especially destructive family conflict). Such arousal may initially be adaptive, increasing the child's capacity to cope with high levels of stress in their environment (Boyce & Ellis, 2005), but may eventually lead to dysregulated behavior and increased rates of psychopathology (Cummings & Davies, 2009).

Higher levels of emotional security are thought to be associated with generally decreased psychophysiological arousal (e.g., Sturge-Apple, Davies, Cicchetti, & Manning, 2012). Given that psychophysiological arousal at bedtime is associated with clinical sleep disorders (Dahl, 1996), increased levels of emotional security during the pre-bedtime period, and correspondingly low levels of psychophysiological arousal, could be a process that promotes child sleep. El-Sheikh and her colleagues have examined how emotional security, as measured in relation to specific family stressors such as inter-parental conflict, affects sleep in school-aged children. Their studies show a positive association between child emotional security and child sleep, both concurrently (El-Sheikh et al., 2007a; El-Sheikh et al., 2007b) and over time (Keller & El-Sheikh, 2011). This series of studies, which provides important evidence that emotional security is associated with sleep, measured emotional security with a questionnaire that focused on child security specifically related to the relationship between the child's parents.

To our knowledge, no research has considered child emotional security within the family system specifically during the pre-bedtime period. Such an adaptation of the emotional security construct may advance our understanding of how family processes facilitate or hinder child sleep. Activities that are thought to promote child emotional security, including warm family interactions, soothing activities, and mutual enjoyment of the pre-bedtime process, may help to promote the down-regulation of child vigilance. Alternatively, activities that diminish children's emotional security, including family conflict and harsh parenting, may hinder vigilance down-regulation. Previous research on the association between emotional security and sleep has focused on school-aged children (El-Sheikh et al., 2007a; El-Sheikh et al., 2007b; Keller & El-Sheikh, 2011) leaving unanswered the question of how the promotion of emotional security is associated with sleep in early childhood, an era during which parents and children are more likely to closely interact during the pre-bedtime period.

## The Current Study

The current study comprehensively examines how actigraphic sleep parameters are related to the pre-bedtime context of sleep. The pre-bedtime sleep context was examined in three ways. First, we examined the consistency of bedtime routines in terms of their content and duration. Second, we examined the quality of the child's home sleep environment – the extent to which the child's sleep space is comfortable, clean, and free of noise and light. Third, we examined the induction of emotional security by considering how parent-child interactions during the pre-bedtime period – such as soothing and comforting (e.g., cuddling) versus conflictual and activating (e.g., yelling, harsh discipline) events – promote or hinder security and sleep. We then examined the association between these measures of pre-bedtime context and child sleep. Based on previous research, we expected that more consistent bedtime routines, higher quality sleep environments, and more security-inducing interactions during the pre-bedtime period would be associated with better sleep (defined in this context as longer sleep durations, earlier bedtimes, more consistent sleep schedules, less fragmented sleep, and shorter latencies to fall asleep). Next, we examined how these measures of pre-bedtime context each jointly predicted the various aspects of child sleep (e.g., sleep duration, variability in sleep timing and duration), using multiple regression. Multiple regression allowed us to determine which of the predictors accounted for the largest proportion of unique variance in the outcome given the other predictors in the model. Based on previous research, we expected each aspect of the pre-bedtime context to be significantly associated with child sleep when considered jointly. However, no previous research has examined how each of these measures of pre-bedtime context are jointly associated with different domains of sleep. Therefore, this second aim was exploratory. Finally, given conceptual overlap between our measures of pre-bedtime context and family SES, we systematically examined how family SES was associated with each of the measures of pre-bedtime context, including examining whether pre-bedtime context mediated the association between family SES and child sleep.

# Method

## Participants

The current study included 546 toddlers (265 female) assessed within two weeks of 30 months of age. These 546 toddlers were part of a larger sample of 611 toddlers who participated in the Toddler Development Study, a multi-site, longitudinal study of child development (Hoyniak et al., 2018). Children who did not complete a pre-bedtime observation (approximately 11% of the overall Toddler Development Study sample) were not included in the current study. Pre-bedtime observations were typically missing due to difficulties scheduling the home observation or families being unwilling to allow an observer in their home. Data for the Toddler Development Study were collected from 2008 to 2018. Participants were recruited from two mid-sized, Midwestern cities and one mid-sized, Mid-Atlantic city. There were no significant differences across the three sites of data collection in the means of any of the major variables of interest (described below). Participants were recruited using a database search based on county birth records, through partnering with community outreach organizations (e.g., Head Start and the Housing Authority), and through public advertisements. Compensation was provided, and all procedures were approved by the relevant Institutional Review Boards at the three research sites. To increase the representativeness of this community sample, very few exclusion criteria were imposed; however, because child capacity to complete the activities of the wider study, including a laboratory self-regulatory battery, children with severe developmental delays were excluded.

The final sample was predominantly White (87%, 4% Latinx, 2% Black, 1% Mixed Race, 4% Other, and 2% Unknown, Not Reported, or Missing), non-Hispanic (96%, 4% Hispanic) and came from predominantly two-parent households (86%; 8% Single Parent, 4% Other, 2% not reported). Primary caregivers in the samples were mostly college educated (79% college degree, 14% some college, 5% high school diploma or less, 2% not reported). Family SES was calculated using the Hollingshead Four Factor Index (Hollingshead, 1975), which takes into account both parents' educational attainment and occupational prestige (based on US Census codes). Both parents' education and occupation scores equally informed estimates when both parents were employed, but only one parent's score informed estimates in families with a single parent or a couple with a non-employed spouse. SES estimates can range from 8 to 66, with higher scores reflecting higher SES. In the current sample, SES ranged from 12.5 to 66, with $M = 48.21$ ($SD = 13.05$), suggesting that the sample was predominantly middle class, although not uniformly so.

## Procedures

At an initial home visit, actigraphs were given to the target child, and primary caregivers were given daily sleep diaries to complete for the target child each night that the actigraph was worn. Children were asked to wear the actigraphs for one to two weeks. Approximately one week after this initial home visit, pairs of trained research assistants visited the family's home to observe the family during the hour leading up to the child's reported bedtime. We chose to focus the home observation on the hour before bedtime to be consistent with prior literature examining sleep behaviors in the hour before bedtime (Meltzer et al., 2013), while not overburdening participants with an overly lengthy home observation. The observers initially interacted with the family (e.g., giving the target child a present, getting a tour of the home, etc.), but after this, the research assistants made themselves as unobtrusive as possible (e.g., listening from the hallway outside of the child's bedroom or wherever the child was put to bed). Primary caregivers wore a microphone that enabled the observers to hear interactions occurring in rooms that they did not enter. The observers took detailed, narrative-style notes of the interactions and activities that occurred during the observation, which they transcribed and elaborated on within 24 hours. Immediately after the visits, they also completed questionnaires about their impressions. The visit ended when the target child was put to bed, but not necessarily asleep.

## Measures

**Bedtime Routines: Sleep Diaries—**Primary caregivers (97% mothers) completed daily sleep diaries that included information about their child's nightly bedtime and sleep routine, including information about the start and end time of the routine and content of the routine, the child's bedtime and wake time, and signaled night awakenings. The sleep diaries were completed for approximately one to two weeks (duration of completion of sleep diaries varied due to family preference and scheduling considerations), concurrently with actigraph data collection to facilitate actigraphy scoring. At two of the research sites, primary caregivers provided information to the research team prior to the first home visit about the typical contents of the child's nightly bedtime routine (e.g., "bath, pajamas, brush teeth, prayers"), if applicable. The research team then customized the family's sleep diaries based on this information by creating a nightly bedtime routine checklist (see sample customized sleep diary in Supplemental Figure 1A). Primary caregivers were asked to complete the checklist each night, marking which steps of the *typical* bedtime routine (as reported by the parents and documented in the sleep diaries) were *actually* completed. As an index of inconsistency in bedtime routines, we calculated the difference between the checklist's number of steps *typically* included in the child's bedtime routine and the number of steps *actually* completed on a given night. For example, if 5 steps were reported to be *typically* a part of the child's bedtime routine, and the family *actually* completed 3 of the steps on a given night, the child would receive a deviation score of 2 for that night. If the family completed more steps than typical on a given night, the absolute value of the difference between the number of steps *typically* completed and the number of steps *actually* completed was used. As such, higher deviation scores always represented more deviation from the *typical* bedtime routine.

If the sleep diaries were not customized prior to distribution, caregivers completed a sleep diary each night that had a checklist of six standard components (shower, pajamas, story, water, TV, brushing teeth; as identified in Staples et al., 2015) and spaces to list additional (or different) steps of the bedtime routine for each night. To be as comparable as possible with the other two sites, the following procedure for calculating deviation was followed: First, based on caregivers' checked components and written-in free response entries on the sleep diaries, we identified a *typical* routine for each individual child. A step was defined as part of the *typical* routine if it occurred on at least 10 of the 14 nights during the data collection period. If fewer nights of sleep diary data were collected, we followed this set of rules for determining if a step was part of the typical routine: a step was defined as part of the *typical* routine if it occurred on $N-2$ or $N-4$, depending on whether 1 or 2 weeks of data were collected, respectively, and where $N$ represents the total number of nights of sleep diary data collection. For each individual night, deviation from the *typical* routine was calculated, such that a score of 1 was assigned for each step that occurred but was not part of the *typical* routine and for each step that did not occur but was part of the *typical* routine. These scores were summed for a total deviation score, with higher scores indicating more deviation from the *typical* routine for a particular night.

Two sleep diary variables were used in analysis: (1) the standard deviation of the average duration of the child's bedtime routine (duration of the bedtime routines was calculated as the duration of time, in minutes, between the start of the child's bedtime routine and the child's bedtime) and (2) the deviation from the typical number of steps (described above). Higher scores indicated less consistency in terms of duration or contents of the bedtime routine. Descriptive statistics for these variables are included in Table 1. The two aspects of inconsistency in the bedtime routine, although only showing a trending correlation ($r$ = .09, $p$ = .08, two-tailed), were aggregated because they are topically related. We combined these variables into a composite bedtime routine inconsistency index by standardizing and averaging them. Higher scores on this bedtime routine inconsistency index indicate more parent-reported inconsistency in the child's bedtime routine.

**Quality of the home sleep environment: Observer impressions—**Both home observers completed a questionnaire immediately after the completion of the home observation— the home checklist—that included 60 items assessing the quality of the home environment. This questionnaire, which included items from the Home Observation for Measurement of the Environment inventory (HOME; Bradley & Caldwell, 1979), has been used in previous research (Dodge, Pettit, & Bates, 1994), and includes additional items designed to assess the quality of the child's sleep space.

From this questionnaire, the subscale focused on child sleep space quality was used in analysis. Each item was scored as either a 0 (*no*, indicating that the stimulus in question was not present) or a 1 (*yes*, indicating that the quality in question was present). This subscale included 18 items assessing the comfort (e.g., "a stuffed animal or other toy is part of the bedtime ritual"), cleanliness (e.g., "bedding is noticeably dirty"), and noise/light level (e.g., "overhead lights or lights that fully illuminate the sleeping space are on while the [child] falls asleep") in the child's designated sleep space. Items were scored such that higher scores indicated lower quality sleep spaces (e.g., noisy or hot bedroom, crowded beds, few comfort items in the bedroom). Item scores were averaged across the two observers, and then summed to create a total subscale score, with higher total scores reflecting poorer quality sleep environments. The Cronbach's alpha value for this subscale was 0.43. This relatively low Cronbach's alpha value is likely attributable to the fact that this subscale assesses a wide variety of items that are related to poor sleep space qualities, but would not necessarily be related to one another (e.g., "the sleeping space is noticeably cold" and "[child] shares a bed with one or more individuals").

**Emotional security induction during the pre-bedtime period—**To measure the extent to which emotional security was induced during the pre-bedtime period, the detailed, and elaborated upon, narrative notes recorded by the home observers were examined using automated text analysis. The text-analytic approach used word frequency counts to identify the frequency of words appearing in the narratives that reflect various aspects of the construct of pre-bedtime emotional security induction. Based on previous research on child emotional security (Davies & Cummings, 1994) and parental emotional availability (Teti et al., 2010), we defined security inducing pre-bedtime environments as those characterized by ample warmth and positivity between parent and child, minimal negativity between parent and child, minimal parental harshness, minimal child noncompliance, and minimal family conflict in general.

A two-step approach was used to compile lists of words reflecting these constructs. First, two graduate students and an undergraduate student (authors of the current study) read a representative portion of the narratives, recording, discussing, and agreeing upon lists of 320 words corresponding with each aspect of the construct of emotional security induction in the pre-bedtime environment. These lists were used as the basis for creating two dictionaries, 1) *security positive:* activities indicative of security induction in the pre-bedtime period (i.e., words reflecting soothing activities, positive parenting strategies, and general, mutual enjoyment of the routine) and 2) *security negative:* activities indicative of less security induction in the pre-bedtime period (i.e., words reflecting family conflict, frustration, discomfort, negative parenting strategies, and child noncompliance/resistance). Frequency count approaches to text analysis rely upon the comprehensiveness of the construct dictionaries; thus, the initial dictionaries were systematically expanded using a semantic covering net. The 20 – 30 most similar words to each target word in the dictionary were extracted from the distributional space produced by the Word2vec software (Mikolov et al., 2013) on English wikipedia. Word2vec is a neural network distributional semantic architecture that starts with randomly initialized word vectors and modifies them with respect to word-context co-occurrences in a large text corpus. The model we trained for this study within Word2vec used 6 context words from left and right of the target words and returned vectors of size 300; all other parameters were set to default. This returned the initial two dictionaries in an expanded form. These dictionaries were then culled to only include theoretically relevant words (total number of words in the final dictionary $N = 1117$). Words in these dictionaries were included so as to identify common word variants (e.g., comfort* to identify comfortable, comforting, comforted, etc.; dictionaries available upon request).

Each home visit narrative was then examined using The Simple Natural Language Processing Tool (SiNLP; Crossley, Allen, Kyle, & MacNamara, 2014), a tool that allows users to analyze texts using customizable content dictionaries. SiNLP calculated the proportion of words in each narrative corresponding with each of our two dictionaries (i.e., security positive words and security negative words), with higher proportions indicative of more security positive or security negative words highlighted in the narratives. Scores from the two home observers were averaged, and then the two variables (i.e., proportion of words in the narrative corresponding with security positive and proportion of words in the narrative corresponding with security negative) were standardized. The unstandardized proportions were quite small (e.g., typically less than 1%), so standardizing the variables allowed us to examine differences between children on a more easily interpretable scale.

**Child sleep: Actigraphy—**Sleep was measured using MicroMini Motionlogger actigraphs from Ambulatory Monitoring, Inc. (Ardsley, NY), watch-like devices placed in soft fabric wristbands worn by the children for approximately one to two weeks (although some children wore the actigraphs longer due to visit scheduling preferences; *M* = 10.13 nights, *SD* = 4.21, range = 4 – 23 nights1). The number of nights of actigraphy data collected varied because family preference was taken into consideration when scheduling the lab visits (actigraphs were returned to the research assistants during this visit), as well as toddler noncompliance with wearing the device and equipment failure. The children were given small gifts every day, at their mothers' discretion, for wearing the device. There were no systematic differences in the number of nights the child wore the actigraph based on family SES, child sex, or parent-reported sleep problems. Actigraphs measure minute-by-minute motor activity to estimate sleep and wake patterns. In line with best practices, sleep diaries were used when scoring the actigraphy data to determine the child's bedtime, rise time, nap start and end times, and any times when the child was not wearing the actigraph (Meltzer, Montgomery-Downs, Insana, & Walsh, 2012). Actigraphs were typically worn on the child's non-dominant wrist, but some toddlers, who refused to wear the actigraph on their wrist, were allowed to wear the device on their ankle (6% of the sample). There were no systematic differences in how the child wore the actigraph based on family SES, child sex, or parent-reported sleep problems. Approximately 18% of the included sample was missing actigraphy data, due to technical failure of the devices, loss/destruction of the actigraph, or a child having fewer than four nights of usable actigraphy data.

Actigraphy data were processed using the Sadeh algorithm (validated for use with children; Sadeh, Sharkey, & Carskadon, 1994) by research assistants who were trained to reliability with one another. When major discrepancies between the actigraphy data and the sleep diary emerged (e.g., if there was a discrepancy between parent-reported bedtime and bedtime as indicated using actigraphy) or if the sleep diaries were incomplete/inaccurate, we used the actigraphy data to determine sleep vs. wakefulness. Once processed, a large set of raw actigraphy variables that were 1) used in prior actigraphy research, 2) consistent with major areas of sleep behavior (e.g., activity, amount, timing), and 3) were not merely a linear combination of already selected variables, were exported from the AW2 software package. Using each child's means/standard deviations across the available days of actigraphy data, we derived four composite variables (see Table 1) based on principal components analysis (Staples et al., 2019): sleep duration, sleep timing, sleep variability, and sleep activity. The composites were formed by summing unweighted standardized indexes for each raw actigraphy variable. Table 1 contains descriptive information on the actigraphy variables included in each composite. The sleep duration composite indexes the general length of the child's nighttime sleep period. The sleep timing composite indexes the relative lateness of sleep schedule. The sleep variability composite indexes night-to-night variability in the timing and duration of sleep. The sleep activity composite indexes motor activity and wake episodes that occur during the sleep period. The four composites represent broad dimensions of sleep that are often examined in the child sleep literature (Meltzer et al., 2012). Each composite showed adequate reliability (sleep duration α = 0.81, sleep timing α = 0.95, sleep variability α = 0.67, and sleep activity α = 0.72). Composite indexes were used instead of single, raw actigraphy variables in order to get more robust measures of the sleep constructs of interest. Aggregate measures provide known measurement advantages over single-variable analysis. This approach also allowed us to reduce the number of variables tested in relation to pre-bedtime context. Using composites provides a systematic way to examine multiple dimensions of sleep without re-running analyses for each of the numerous variables exported from actigraphy software. These composites were used in all models, along with a single index of latency to fall asleep, a variable that had near-zero loadings on the four sleep composites.

### Analysis Plan

To examine how pre-bedtime context was associated with sleep, we used a two-step approach. First, we examined the correlations between each aspect of the pre-bedtime context (i.e., consistency of bedtime routines, quality of the sleep environment, and emotional security induction across the pre-bedtime period) and the various measures of child sleep (i.e., duration, timing, variability, activity, and latency to fall asleep). We also expected overlap between family SES and the measures of pre-bedtime context and child sleep, so we examined the association between family SES and all of the variables used in analysis. We then examined how each pre-bedtime index, when examined jointly, predicted sleep across each of the domains using a multiple regression approach. Each of the measures of pre-bedtime context were examined simultaneously (i.e., in the same block) to predict the various measures of child sleep. Again, given the overlap between family SES and our constructs of interest, we also controlled for SES in all multiple regression analyses.

Finally, we were interested in whether pre-bedtime context mediated the association between family SES and sleep. We planned to conduct this line of analysis post-hoc, only if the conditions of cross-sectional mediation were met (i.e., significant associations between family SES and pre-bedtime context, family SES and sleep, and pre-bedtime context and sleep). If the conditions of statistical mediation were met, we planned to use the approach recommended by Hayes (2009; 2013) to test for statistical mediation. The indirect paths between SES and sleep outcomes through the proposed pre-bedtime context mediators were examined in separate models. The indirect path was estimated using a bootstrapping approach (1000 iterations). All mediation analyses were conducting using the mediation package for R (Tingley et al., 2014). All analyses were conducted in R (R Development Core Team, 2014).

## Results

Descriptive statistics for and correlations between the major variables included in analysis are presented in Table 2.

### Associations among Measures of Pre-bedtime Context

The measures of pre-bedtime context converged with one another in understandable ways, but also showed considerable non-overlap, suggesting that they might measure similar, but not exactly the same, qualities. The measure of bedtime routine inconsistency was not correlated with quality of the home environment or security positive interactions, but did have a small, significant correlation with the security negative interactions. Family SES also showed some understandable and statistically significant relations with three of the indexes of pre-bedtime context. Children from higher SES backgrounds had more consistent bedtime routines, higher quality sleep spaces, and more security positive interactions during the pre-bedtime period. There was no significant association between family SES and security negative interactions.

### Pre-bedtime Context and Child Sleep

Pre-bedtime context and child sleep were correlated to a modest degree (significant correlations ranged from .11 to .22). Children who had less consistent bedtime routines tended to have later sleep timing and more night-to-night variability in their sleep schedules. Children with poorer quality sleep environments, based on observer ratings, got less sleep at night, had later sleep timing, had more night-to-night variability in their sleep schedules, had more active sleep, and took longer to fall asleep. Children whose pre-bedtime periods were characterized by higher levels of emotional security induction (i.e., scores on the security positive index) tended to get more sleep at night, had earlier sleep timing, and had less night-to-night variability in their sleep schedules. However, children whose pre-bedtime periods were characterized by security incompatible activities (i.e., scores on the security negative index) tended to experience more night-to-night variability in their sleep schedules, but they did not differ in terms of sleep duration or timing. Family SES was associated with all of the measures of child sleep, except for sleep latency. Children from higher SES backgrounds got more sleep at night, had earlier sleep timing, had less night-to-night variability in their sleep schedules, and had more active sleep.

### Multiple Regression Analyses

We next conducted multiple regression analyses, summarized in Table 3, to examine how the indexes of pre-bedtime context, when considered jointly along with family SES, predicted each aspect of sleep. We did not include either sleep activity or sleep latency in this set of analyses because only sleep environment quality was significantly associated with these sleep variables.

Findings indicated that the pre-bedtime context indexes complemented one another in predicting child sleep. Broadly, children slept better in homes that were regarded as having higher quality pre-bedtimes, as indicated by mother reports of regularity of bedtime routines, observer ratings of sleep space quality, and by text analytic markers of emotional security induction. Effect sizes were generally small. Sleep duration was only predicted by poorer quality sleep environments; children with poorer quality sleep environments slept for shorter durations. However, neither bedtime routine consistency, nor the indexes of emotional security induction (i.e., security positive or security negative), significantly predicted sleep duration when considered jointly with sleep environment quality and family SES. The sleep timing index was significantly predicted by three of the four pre-bedtime measures as well as family SES. Children with less consistent bedtime routines, poorer quality sleep environments, fewer security-promoting experiences during the pre-bedtime period, and families with lower SES tended to go to bed later. The sleep variability index was also predicted by three pre-bedtime indexes. Children with inconsistent bedtime routines, poorer quality sleep environments, and more security negative experiences had higher night-to-night variability in their sleep schedules.

### Pre-bedtime Context as a Mediator of the Association between SES and Sleep

Our findings demonstrating significant associations between family SES and pre-bedtime context, family SES and sleep, and pre-bedtime context and sleep (see Table 2) suggest that the preliminary conditions of statistical, cross-sectional mediation were satisfied. As bedtime routine consistency, sleep environment quality, and security positive interactions were all significantly associated with family SES, we focused specifically on these variables as possible mediators. We did not include sleep latency or sleep activity in this analysis, because of the lack of observed associations with pre-bedtime context. The results of our post-hoc, cross-sectional mediation analyses are shown in Table 4. All associations examined as a part of the mediation models were in the expected direction. Findings indicated that bedtime routine consistency statistically mediated the association between family SES and both sleep timing and sleep variability. Poor quality sleep environments statistically mediated the association between family SES and sleep duration, sleep timing, and sleep variability. Finally, security positive experiences statistically mediated the association between family SES and sleep duration, sleep timing, and sleep variability. All other examined mediation models were non-significant. The proportion of the effect of family SES on sleep explained by the mediators ranged from .14 to .25.

## Discussion

The current study demonstrates that pre-bedtime context is associated with sleep in toddlers. Parent-reported consistency of bedtime routines, observer-reported quality of the child's sleep environment, and text analytic measures of emotional security induction, were all associated with child sleep, but these patterns of association differed depending on which sleep domain was examined. Our findings add to the literature on the importance of physical environment and emotional security induction, in conjunction with a consistent bedtime routine, for young children's sleep.

We found that low levels of consistency in bedtime routines in toddlerhood, in terms of duration and content of the routine, were associated with later sleep timing and more night-to-night variability in sleep schedules, but not with sleep duration, sleep activity, or sleep latency. Previous research suggests that higher levels of night-to-night adherence to an established bedtime routine is associated with better child sleep (Mindell et al., 2009; Mindell et al., 2015; Mindell & Williamson, 2018; Prokasky et al., 2019; Staples et al., 2015). Many of the prior findings involve parent reports of both the bedtime routine and sleep, which could inflate associations due to shared method variance. However, the present study confirms that parent-reports of inconsistent bedtime routines are associated with later bedtimes and more variable sleep schedules, as measured using actigraphs. Additionally, even when controlling for other aspects of pre-bedtime context and family SES, the consistency of bedtime routines still significantly predicted sleep timing and sleep variability, suggesting the robust nature of the association between the consistency of bedtime routines and child sleep.

Quality of the child's sleep environment, an index measuring the comfort, cleanliness, and noise/light level of the child's sleep space, showed the most robust association with child sleep when compared to the other measures of pre-bedtime context. Poorer quality sleep environments were associated with shorter sleep durations, later sleep timing, more sleep variability, more sleep activity, and longer sleep latencies. Even when controlling for other aspects of pre-bedtime context and family SES, the quality of the child's sleep space still significantly predicted sleep duration, sleep timing, and sleep variability, suggesting the importance of high-quality sleep spaces for child sleep. Our findings correspond with research showing that poorer quality sleep environments are associated with worse sleep (Bagley et al., 2015; Doane et al., 2019; Kahn et al., 1989; Milan et al., 2007; Rona et al., 1998), and underscore the potential clinical importance of ensuring high quality sleep spaces.

Emotional security induction during the pre-bedtime period, quantified using a text analysis of observer narratives, was associated with several sleep variables. Pre-bedtime periods high in security positive interactions were associated with longer sleep duration, earlier sleep timing, and less sleep variability. Pre-bedtime periods high in security negative interactions were associated with more variable sleep schedules, but not with sleep duration, timing, or activity. It is interesting that our two text-analytic constructs (security positive and negative) were not simple opposites of one another. Instead, security positive and security negative were only modestly correlated, and the two indexes showed differing patterns of correlation with sleep. This could be due to imprecision in the way in which we measured emotional security induction in our text analytic approach, or it could perhaps suggest that these are separate dimensions. Children could plausibly experience pre-bedtime periods that are characterized by both security negative interactions (e.g., inter-parental conflict) and security positive interactions (e.g., soothing, warm activities). Narratives were analyzed in their entirety, with no contrasts between different family members interacting with the target child. Therefore, emotional security induction was quantified across the entire context of the home environment, including anyone who interacted with the child on the night of the observation. This often included mothers, but also included fathers, grandparents, and siblings. However, we are interested in father involvement in bedtime routines, as there is a dearth of information about this topic, and we plan to explicitly examine father involvement specifically in the pre-bedtime period in future work.

When considering our indexes of emotional security induction along with the other measures of pre-bedtime context and family SES, we found that emotional security induction significantly added to the prediction of the sleep variables over and beyond these other variables. However, security positive and security negative again operated differentially. The security positive construct made a unique contribution in predicting sleep timing, and the security negative construct uniquely predicted sleep variability. These findings suggest that some qualities of security induction that are not shared with the other measured qualities of the home are involved in the process that leads to late versus early bedtimes and more variable sleep schedules. In one plausible scenario involving security positive events, toddlers who experience a low rate of security-inducing events may press for later bedtimes in the service of more moments of connection with the parents. In another plausible scenario, the association between security negative and sleep variability could reflect a bidirectional process of child resistance and parent irritation due to dyssynchrony between child sleepiness and the parents' schedule on a given night. From a parent's perspective, one of the advantages of a regular sleep schedule is that it takes advantage of a child's circadian cycles in wakefulness versus somnolence, which could promote compliance at bedtimes. Children without a regular sleep schedule may have more difficult pre-bedtime periods, characterized by bidirectional conflicts with caregivers. Of note, however, even when considered together, the measures of pre-bedtime context and family SES explained a relatively small portion of the variance in child sleep duration, timing, and variability ($.03 < R^2 < .11$). This suggests that there is substantial variance in these features of child sleep that is not accounted for by variations in pre-bedtime context or family SES.

## Pre-bedtime Context, Sleep, and Family SES

Higher family SES was associated with more consistent bedtime routines, better quality sleep spaces, and more security positive interactions. Consistent with prior research, children from higher SES families were more likely to have consistent bedtime routines (Hale Berger, LeBourgeois, & Brooks-Gunn, 2009; Henderson & Jordan, 2009). Further, the consistent use of bedtime routines statistically mediated the association between family SES and both sleep timing and sleep variability. Children from lower SES families were more likely to have poorer quality sleep environments, and poorer quality sleep spaces statistically mediated the association between family SES and sleep duration, sleep timing, and sleep variability. Poorer quality sleep spaces (e.g., those that are noisy, crowded, uncomfortable) have been hypothesized as a plausible mechanism of the effect of SES on child sleep (Bagley et al., 2015; Doane et al., 2019; El-Sheikh et al., 2013). Our findings add further support to this line of research. Finally, higher family SES was associated with more positive, comforting interactions in the hour before bedtime, and security positive experiences mediated the association between family SES and both sleep duration and sleep variability. The results of these mediation analyses help to identify plausible processes through which SES influences child sleep outcomes, thus identifying potential targets for efforts aimed at reducing adverse effects of lower SES on child sleep. However, as there are known problems in assessing mediation cross-sectionally (Maxwell, Cole, & Mitchell, 2011), the results of this mediation model should be interpreted with some caution and will need to be replicated in the future using a longitudinal mediation approach. We found no association between SES and security negative interactions, suggesting that the security negative interactions—including family conflict, harsh parenting, and child discomfort—are similarly prevalent across income levels. However, this non-finding could also pertain to the relatively low number of lower-SES families, which might have restricted the range of security negative interactions observed and our power to detect an effect.

## Strengths and Limitations

The current study has several important strengths. First, sleep was measured using actigraphy data, which were condensed into composite indexes. These composites reflected the broad dimensions of sleep that are often measured (i.e., timing, duration, variability, and activity). Different patterns of association emerged between the measures of pre-bedtime context and the sleep composites, supporting our choice to use a comprehensive range of actigraphy variables. Using only one or two raw actigraphy indexes may not be sufficient to identify significant patterns or overall patterns of association. The most robust associations with our pre-bedtime predictors of interest emerged with the sleep variability and sleep timing composites, underscoring the importance of considering such variables in future analyses. Additionally, in the current study, the family context of sleep was examined using more than one measurement technique, including parent diary reports and observer impressions recorded in both structured (i.e., observer questionnaires) and free-response (i.e., narrative-style notes) forms. Next, this study utilized a novel method, text analysis, to operationalize the important construct of pre-bedtime emotional security induction, and assessed family interactions in a naturalistic context that is highly relevant to children's sleep. Young children's sleep has been increasingly studied, but not often in as full an ecological context as the current study (see El-Sheikh & Buckhalt, 2015; Camerota et al., 2019; Cummings, Koss, & Bergman, 2011 for discussion of the need for increased research on the family context of sleep). Finally, the study included a large, intensively assessed sample of toddlers. Relatively little research has focused on child sleep, bedtime routines, and family process specifically in toddlerhood (see Bernier et al., 2013; Peltz et al., 2016; Sadeh et al., 2009 for examples), and this study adds to these studies, helping to fill an important gap in the literature.

The current study also has limitations. First, the presence of observers in the home in the hour before bedtime may have altered the dynamics of parent-child interactions during this time. Although our observers tried to be as unobtrusive as possible (e.g., staying outside of the child's room and using a microphone to listen to interactions), it is important to take into consideration the social desirability pressures the presence of an observer may have engendered in the family. Any observational system has limits in its sensitivity and biases in capturing the complex reality of families' interactions. Our observers were carefully chosen and trained, and our observational training materials are available upon request. Replications and comparisons will be essential. Additionally, our home observations lasted for approximately one hour to limit demands on the family. However, multiple visits could yield more accurate measures of the qualities considered in the current analysis. And more extended observations, perhaps with the aid of video and audio devices, could allow us to describe processes between the time the child is put to bed and the time the child actually falls asleep, which would be of high interest, given the incidence of settling difficulties and bedtime resistance in toddlers (Crowell, Keenner, Ginsburg, & Anders, 1987). Next, our use of a customized checklist for bedtime routine activities, while useful, may have increased the likelihood that parents simply checked off each item in the list, regardless of whether they actually did those activities, and also may have implicitly suggested that families *should* be following a bedtime routine when they may not have used a bedtime routine prior. Next, actigraphy, while an excellent, objective measure of sleep, may be prone to overestimating wakefulness when used with young children (Sitnick et al., 2008). Additionally, the study was correlational, and while we may assume that more consistent routines, higher quality sleep environments, and higher levels of emotional security lead to better sleep, the current study's findings cannot establish causality. It may well be that the child's characteristics influence the transactions that we see as parental induction of emotional security. In the future, we will examine these associations longitudinally to confirm the directionality of the associations between pre-bedtime context and sleep and examine changes in these constructs over time. Finally, and perhaps most importantly, the current study focused on a relatively homogenous sample of primarily White, non-Hispanic children from two-parent households. While this is reflective of the communities in which these families resided (two mid-sized, Midwestern cities and one mid-sized, Mid-Atlantic city), this is not reflective of the nation as a whole and limits the generalizability of our findings. Given research suggesting sleep disparities among racial/ethnic minorities (Crosby, LeBourgeois, & Harsh, 2005; Hale et al., 2009; Smith, Hardy, Hale, & Gazmararian, 2019; Williamson et al., 2017), it will be crucial to replicate our findings in more diverse samples to examine whether these aspects of pre-bedtime context mediate the association between SES and sleep outcomes. Interventions aimed at improving these aspects of pre-bedtime context (e.g., promoting high quality sleep spaces) could be crucial for reducing sleep disparities.

## Conclusion

The current study demonstrated an association between toddlers' pre-bedtime context, including the consistency of bedtime routines, the quality of the child's sleep environment, and the induction of emotional security and multiple aspects of their sleep. Our findings support the value of considering the context of toddlers' sleep, especially a context that is consistent, developmentally appropriate, physically comfortable, and security-inducing. Importantly, our results suggest that sleep space quality and pre-bedtime security positive experiences mediate the association between family SES and numerous aspects of sleep. This study is the first of its kind to provide rigorous, empirical data using multiple methodologies to suggest that when parents adhere to a consistent bedtime routine, maintain a healthy sleep space for their child, and use positive, security inducing activities during the routine, their child will likely experience better sleep. Although we recognize limitations in causal inferences, these findings may be useful clinically, especially considering the number of families facing child sleep difficulties (Owens, 2007) and the sequela of consequences associated with poor sleep in childhood (Astill, Van der Heijden, Van IJzendoorn, & Van Someren, 2012; Dutil et al., 2018). The findings may also be useful in promoting good sleep for children before clinical sleep problems arise, underscoring the importance of implementing bedtime routines, high quality sleep spaces, and pre-bedtime security to promote sleep in young children.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.


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## References


Acebo C, Sadeh A, Seifer R, Tzischinsky O, Hafer A, & Carskadon MA (2005). Sleep/wake patterns derived from activity monitoring and maternal report for healthy 1-to 5-year-old children. Sleep, 28, 1568–1577. doi: 10.1093/sleep/28.12.1568 [PubMed: 16408417]

Adam EK, Snell EK, & Pendry P (2007). Sleep timing and quantity in ecological and family context: A nationally representative time-diary study. Journal of Family Psychology, 21, 4–19. doi: 10.1037/0893-3200.21.1.4 [PubMed: 17371105]

Astill RG, Heijden KBVder, IJzendoorn MHV, & Someren EJV (2012). Sleep, cognition, and behavioral problems in school-age children: A century of research meta-analyzed. Psychological Bulletin, 138, 1109–1138. doi: 10.1037/a0028204 [PubMed: 22545685]

Bagley EJ, Kelly RJ, Buckhalt JA, & El-Sheikh M (2015). What keeps low-SES children from sleeping well: The role of presleep worries and sleep environment. Sleep Medicine, 16, 496–502. doi: 10.1016/j.sleep.2014.10.008 [PubMed: 25701537]

Bell BG, & Belsky J (2008). Parents, parenting, and children's sleep problems: Exploring reciprocal effects. British Journal of Developmental Psychology, 26, 579–593. doi: 10.1348/026151008X285651

Bernier A, Bélanger M-È, Bordeleau S, & Carrier J (2013). Mothers, fathers, and toddlers: Parental psychosocial functioning as a context for young children's sleep. Developmental Psychology, 49, 1375–1384. doi: 10.1037/a0030024 [PubMed: 22985297]

Billows M, Gradisar M, Dohnt H, Johnston A, McCappin S, & Hudson J (2009). Family disorganization, sleep hygiene, and adolescent sleep disturbance. Journal of Clinical Child & Adolescent Psychology, 38(5), 745–752. [PubMed: 20183658]

Boyce WT, & Ellis BJ (2005). Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. Development and Psychopathology. Special Issue: Multiple Levels of Analysis, 17, 271–301.

Bradley RH, & Caldwell BM (1979). Home observation for measurement of the environment: A revision of the preschool scale. American Journal of Mental Deficiency, 84, 235–244. [PubMed: 93417]

Brown SJ, Rhee KE, & Gahagan S (2015). Reading at bedtime associated with longer nighttime sleep in latino preschoolers. Clinical Pediatrics, 55, 525–531. doi: 10.1177/0009922815593907 [PubMed: 26178036]

Crossley SA, Allen LK, Kyle K, & McNamara DS (2014). Analyzing discourse processing using a simple natural language processing tool. Discourse Processes, 51, 511–534. doi: 10.1080/0163853X.2014.910723

Crowell J, Kenner M, Ginsburg N, & Anders TF (1987). Sleep Habits in Toddlers 18 – 36 Months Old. Journal of the American Academy of Child & Adolescent Psychiatry, 26, 510–515. [PubMed: 3654502]

Cummings EM, & Davies P (1996). Emotional security as a regulatory process in normal development and the development of psychopathology. Development and Psychopathology. Special Issue: Reflecting on the Past and Planning for the Future of Developmental Psychopathology, 8, 123–139. doi: 10.1017/S0954579400007008

Cummings EM, & Miller-Graff LE (2015). Emotional security theory: An emerging theoretical model for youths' psychological and physiological responses across multiple developmental contexts. Current Directions in Psychological Science, 24, 208–213. doi: 10.1177/0963721414561510

Cummings EM, Schermerhorn AC, Davies PT, Goeke-Morey MC, & Cummings JS (2006). Interparental discord and child adjustment: Prospective investigations of emotional security as an explanatory mechanism. Child Development, 77(1), 132–152. [PubMed: 16460530]

Davies PT, & Cummings EM (1994). Marital conflict and child adjustment: An emotional security hypothesis. Psychological Bulletin, 116, 387–411. doi: 10.1037/0033-2909.116.3.387 [PubMed: 7809306]

Dahl RE (1996). The regulation of sleep and arousal: Development and psychopathology. Development and Psychopathology, 8, 3–27. doi: 10.1017/s0954579400006945

Dahl RE, & El-Sheikh M (2007). Considering sleep in a family context: Introduction to the special issue. Journal of Family Psychology, 21, 1–3. doi: 10.1037/0893-3200.21.1.1 [PubMed: 17371104]

Doane LD, Breitenstein RS, Beekman C, Clifford S, Smith TJ, & Lemery-Chalfant K (2019). Early life socioeconomic disparities in children's sleep: The mediating role of the current home environment. Journal of Youth and Adolescence, 48, 56–70. [PubMed: 30121716]

Dodge KA, Pettit GS, & Bates JE (1994). Socialization mediators of the relation between socioeconomic status and child conduct problems. Child Development, 65, 649–665. [PubMed: 8013245]

Dubois-Comtois K, Pennestri M-H, Bernier A, Cyr C, & Godbout R (2019). Family Environment and Preschoolers' Sleep: The Complementary Role of Both Parents. Sleep Medicine, 58, 114–122. doi: 10.1016/j.sleep.2019.03.002 [PubMed: 31146123]

Dutil C, Walsh JJ, Featherstone RB, Gunnell KE, Tremblay MS, Gruber R, Weiss SK, Cote KA, Sampson M, & Chaput J-P (2018). Influence of sleep on developing brain functions and structures in children and adolescents: A systematic review. Sleep Medicine Reviews, 42, 184–201. doi: 10.1016/j.smrv.2018.08.003 [PubMed: 30241996]

El-Sheikh M, Bagley EJ, Keiley M, Elmore-Staton L, Chen E, & Buckhalt JA (2013). Economic adversity and children's sleep problems: Multiple indicators and moderation of effects. Health Psychology, 32, 849–859. doi: 10.1037/a0030413 [PubMed: 23148451]

El-Sheikh M, & Buckhalt JA (2015). II. Moving sleep and child development research forward: Priorities and recommendations from the SRCD-sponsored forum on sleep and child development. Monographs of the Society for Research in Child Development, 80, 15–32. doi: 10.1111/mono.12142 [PubMed: 25704733]

El-Sheikh M, Buckhalt JA, Keller PS, Cummings EM, & Acebo C (2007a). Child emotional insecurity and academic achievement: The role of sleep disruptions. Journal of Family Psychology, 21, 29–38. doi: 10.1037/0893-3200.21.1.29 [PubMed: 17371107]

El-Sheikh M, Buckhalt JA, Cummings EM, & Keller P (2007b). Sleep disruptions and emotional insecurity are pathways of risk for children. Journal of Child Psychology and Psychiatry, 48, 88–96. doi: 10.1111/j.1469-7610.2006.01604.x [PubMed: 17244274]

Freeman KA (2006). Treating bedtime resistance with the bedtime pass: a systematic replication and component analysis with 3-year-olds. Journal of Applied Behavior Analysis, 39, 423–428. doi: 10.1901/jaba.2006.34-05 [PubMed: 17236339]

Galland BC, Taylor BJ, Elder DE, & Herbison P (2012). Normal sleep patterns in infants and children: a systematic review of observational studies. Sleep Medicine Reviews, 16, 213–222. doi: 10.1016/j.smrv.2011.06.001 [PubMed: 21784676]

Garrison MM, Liekweg K, & Christakis DA (2011). Media Use and Child Sleep: The Impact of Content, Timing, and Environment. Pediatrics, 128, 29–35. doi: 10.1542/peds.2010-3304 [PubMed: 21708803]

Gaylor EE, Burnham MM, Goodlin-Jones BL, & Anders TF (2005). A longitudinal follow-up study of young children's sleep patterns using a developmental classification system. Behavioral Sleep Medicine, 3, 44–61. [PubMed: 15639757]

Hale L, Berger LM, LeBourgeois MK, & Brooks-Gunn J (2009). Social and demographic predictors of preschoolers' bedtime routines. Journal of Developmental and Behavioral Pediatrics: JDBP, 5, 394–402.

Hale L, Berger LM, LeBourgeois MK, & Brooks-Gunn J (2011). A longitudinal study of preschoolers' language-based bedtime routines, sleep duration, and well-being. Journal of Family Psychology, 25, 423–433. doi: 10.1037/a0023564 [PubMed: 21517173]

Hayes AF (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. Communication Monographs, 76, 408–420. doi: 10.1080/03637750903310360

Hayes AF (2013). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York: Guilford Press.

Henderson JA, & Jordan SS (2009). Development and preliminary evaluation of the bedtime routines questionnaire. Journal of Psychopathology and Behavioral Assessment, 32, 271–280. doi: 10.1007/s10862-009-9143-3

Hollingshead AB (1975). Four factor index of social status. Unpublished work.

Hoyniak CP, Bates JE, Staples AD, Rudasill KM, Molfese DL, & Molfese VJ (2018). Child sleep and socioeconomic context in the development of cognitive abilities in early childhood. Child Development, 28, 1568–20. doi: 10.1111/cdev.13042

Johnson CM (1991). Infant and toddler sleep: A telephone survey of parents in one community. Journal of Developmental and Behavioral Pediatrics, 12, 108–114. [PubMed: 2045483]

Kahn A, Van de Merckt C, Rebuffat E, Mozin MJ, Sottiaux M, Blum D, & Hennart P (1989). Sleep problems in healthy preadolescents. Pediatrics, 84, 542–546. [PubMed: 2788868]

Keller P, & El-Sheikh M (2011). Children's emotional security and sleep: Longitudinal relations and directions of effects. Journal of Child Psychology and Psychiatry, 52, 64–71. doi: 10.1111/j.1469-7610.2010.02263.x [PubMed: 20500540]

Koopman-Verhoeff ME, Serdarevic F, Kocevska D, Bodrij FF, Mileva Seitz VR, Reiss I, et al. (2019). Preschool family irregularity and the development of sleep problems in childhood: A longitudinal study. Journal of Child Psychology and Psychiatry, 1021, 276–285. doi: 10.1111/jcpp.13060

Koulouglioti C, Cole R, Moskow M, McQuillan B, Carno M-A, & Grape A (2014). The longitudinal association of young children's everyday routines to sleep duration. Journal of Pediatric Health Care, 28, 80–87. doi: 10.1016/j.pedhc.2012.12.006 [PubMed: 23360666]

Maxwell SE, Cole DA, & Mitchell MA (2011). Bias in cross-sectional analyses of longitudinal mediation: Partial and complete mediation under an autoregressive model. Multivariate Behavioral Research, 46, 816–841. doi: 10.1080/00273171.2011.606716 [PubMed: 26736047]

McDonald L, Wardle J, Llewellyn CH, van Jaarsveld CH, & Fisher A (2014). Predictors of shorter sleep in early childhood. Sleep Medicine, 15, 536–540. doi: 10.1016/j.sleep.2014.01.005 [PubMed: 24726571]

Meltzer LJ, Avis KT, Biggs S, Reynolds AC, Crabtree VM, & Bevans KB (2013). The Children's Report of Sleep Patterns (CRSP): A Self-Report Measure of Sleep for School-Aged Children. Journal of Clinical Sleep Medicine, 9, 235–245. doi: 10.5664/jcsm.2486 [PubMed: 23493949]

Meltzer LJ, & McLaughlin Crabtree V (2015). Pediatric sleep problems: A clinician's guide to behavioral interventions. Washington, DC, US: American Psychological Association. doi: 10.1037/14645-000

Meltzer LJ, Montgomery-Downs HE, Insana SP, & Walsh CM (2012). Use of actigraphy for assessment in pediatric sleep research. Sleep Medicine Reviews, 16, 463–475. doi: 10.1016/j.smrv.2011.10.002 [PubMed: 22424706]

Mikolov T, Sutskever I, Chen K, Corrado GS, & Dean J (2013). Distributed representations of words and phrases and their compositionality. Paper presented at the Advances in Neural Information Processing Systems.

Milan S, Snow S, & Belay S (2007). The context of preschool children's sleep: Racial/ethnic differences in sleep locations, routines, and concerns. Journal of Family Psychology, 21, 20–28. doi: 10.1037/0893-3200.21.1.20 [PubMed: 17371106]

Mindell JA, Li AM, Sadeh A, Kwon R, & Goh D (2015). Bedtime routines for young children: A dose-dependent association with sleep outcomes. Sleep, 38, 717–722. doi: 10.5665/sleep.4662 [PubMed: 25325483]

Mindell JA, Meltzer LJ, Carskadon MA, & Chervin RD (2009). Developmental aspects of sleep hygiene: Findings from the 2004 National Sleep Foundation Sleep in America Poll. Sleep Medicine, 10, 771–779. doi: 10.1016/j.sleep.2008.07.016 [PubMed: 19285450]

Mindell JA, & Owens JA (2015). A clinical guide to pediatric sleep: Diagnosis and management of sleep problems. Lippincott Williams & Wilkins.

Mindell JA, Telofski LS, Wiegand B, & Kurtz ES (2009). A nightly bedtime routine: Impact on sleep in young children and maternal mood. Sleep, 32, 599–606. [PubMed: 19480226]

Mindell JA, & Williamson AA (2018). Benefits of a bedtime routine in young children: Sleep, development, and beyond. Sleep Medicine Reviews, 40, 93–108. doi: 10.1016/j.smrv.2017.10.007 [PubMed: 29195725]

Moore BA, Friman PC, Fruzzetti AE, & MacAleese K (2007). Brief report: Evaluating the bedtime pass program for child resistance to bedtime—A randomized, controlled trial. Journal of Pediatric Psychology, 32(3), 283–287. doi: 10.1093/jpepsy/jsl025 [PubMed: 16899650]

National Sleep Foundation. (2020, June 01). What is Sleep Hygiene?Retrieved from https://www.sleepfoundation.org/articles/sleep-hygiene

Owens J (2007). Classification and epidemiology of childhood sleep disorders. Sleep Medicine Clinics, 2, 353–361. doi: 10.1016/j.jsmc.2007.05.009

Owens JA, Spirito A, & McGuinn M (2000). The Children's Sleep Habits Questionnaire (CSHQ): Psychometric properties of a survey instrument for school-aged children. Sleep, 23, 1043–1052. [PubMed: 11145319]

Peltz JS, Rogge RD, Sturge-Apple ML, O'Connor TG, & Pigeon WR (2016). Reciprocal influences among family processes and toddlers' sleep problems. Journal of Family Psychology, 30, 720–731. doi: 10.1037/fam0000202 [PubMed: 27243101]

Prokasky A, Fritz M, Molfese VJ, & Bates JE (2019). Night-to-night variability in the bedtime routine predicts sleep in toddlers. Early Childhood Research Quarterly, 49, 18–27. doi: 10.1016/j.ecresq.2019.05.004 [PubMed: 32201454]

R Development Core Team (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Rona RJ, Li L, Gulliford MC, & Chinn S (1998). Disturbed sleep: Effects of sociocultural factors and illness. Archives of Disease in Childhood, 78, 20–25. doi: 10.1136/adc.78.1.20 [PubMed: 9534671]

Sadeh A, Mindell JA, Luedtke K, & Wiegand B (2009). Sleep and sleep ecology in the first 3 years: A web-based study. Journal of Sleep Research, 18(1), 60–73. doi: 10.1111/j.1365-2869.2008.00699.x [PubMed: 19021850]

Singh GK, & Kenney MK (2013). Rising prevalence and neighborhood, social, and behavioral determinants of sleep problems in US children and adolescents, 2003–2012. Sleep Disorders, 2013, 1–15. doi: 10.1155/2013/394320

Sitnick SL, Goodlin-Jones BL, & Anders TF (2008). The use of actigraphy to study sleep disorders in preschoolers: Some concerns about detection of nighttime awakenings. Sleep, 31, 395–401. doi: 10.1093/sleep/31.3.395 [PubMed: 18363316]

Smith JP, Hardy ST, Hale LE, & Gazmararian JA (2018). Racial disparities and sleep among preschool aged children: a systematic review. Sleep Health, 5, 49–57. doi: 10.1016/j.sleh.2018.09.010 [PubMed: 30670165]

Spilsbury JC, Storfer-Isser A, Drotar D, Rosen CL, Kirchner HL, & Redline S (2005). Effects of the home environment on school-aged children's sleep. Sleep, 28, 1419–1427. [PubMed: 16335483]

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

Sturge-Apple ML, Davies PT, Cicchetti D, & Manning LG (2012). Interparental violence, maternal emotional unavailability and children's cortisol functioning in family contexts. Developmental Psychology, 48(1), 237–249. doi: 10.1037/a0025419 [PubMed: 21967568]

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

Tingley D, Yamamoto T, Hirose K, Keele L, Imai K (2014). "mediation: R Package for Causal Mediation Analysis." Journal of Statistical Software, 59(5), 1–38. http://www.jstatsoft.org/v59/i05/. [PubMed: 26917999]

Tomfohr-Madsen LM, Cameron EE, Dhillon A, MacKinnon A, Hernandez L, Madigan S, & Tough S (2020). Neighborhood socioeconomic status and child sleep duration: A systematic review and meta-analysis. Sleep Health. doi: 10.1016/j.sleh.2020.02.012

Williamson AA, Rubens SL, Patrick KE, Moore M, & Mindell JA (2017). Differences in sleep patterns and problems by race in a clinical sample of Black and White preschoolers. Journal of Clinical Sleep Medicine, 13, 1281–1288. doi: 10.5664/jcsm.6798 [PubMed: 28992828]

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**Table 1.**

Variables included in bedtime routine inconsistency and sleep composites, along with means and standard deviations

| **Composite** | **Variable Names** | ***M (SD)*** |
|---|---|---|
| Bedtime Routine Inconsistency | Sleep Diary: *SD* of bedtime routine duration (min) | 27.25 (42.03) |
| | Sleep Diary: Bedtime Routine Deviation Score | 1.22 (.98) |
| Sleep Duration | Actigraphy: Avg. sleep period (hr) | 9.70 (0.71) |
| | Actigraphy: Avg duration of time in bed (hr) | 10.45 (0.70) |
| | Actigraphy: Avg. duration asleep in bed (hr) | 8.17 (1.08) |
| Sleep Timing | Actigraphy: Avg. time of midsleep (HH:MM in 24-hour time) | 02:18 (00:43) |
| | Actigraphy: Avg. time of sleep onset (HH:MM in 24-hour time) | 21:29 (00:50) |
| | Actigraphy: Avg. bedtime (HH:MM in 24-hour time) | 20:50 (00:47) |
| Sleep Variability | Actigraphy: *SD* of time of sleep onset | 0.70 (0.44) |
| | Actigraphy: *SD* of duration of time in bed | 48.38 (22.55) |
| | Actigraphy: *SD* of duration of sleep period | 57.24 (27.26) |
| | Actigraphy: *SD* of time of midsleep | 0.52 (0.29) |
| | Actigraphy: *SD* of bedtime | 0.58 (0.38) |
| | Actigraphy: *SD* of min asleep in bed | 60.96 (27.75) |
| Sleep Activity | Actigraphy: Avg. time (min) awake after sleep onset | 90.19 (48.50) |
| | Actigraphy: *SD* of avg. min to min activity levels | 35.07 (10.54) |
| | Actigraphy: Avg number of awakenings (lasting 5 min or more) | 4.66 (2.23) |
| | Actigraphy: Avg. duration (min) of longest wake episode (after sleep onset) | 32.48 (21.01) |
| | Actigraphy: Avg. percent of active epochs (after sleep onset) | 51.86 (12.36) |

*Note: SD* = standard deviation; min = minute; hr = hour; avg = average

**Table 2.**

Descriptive statistics and bivariate correlations between variables included in analysis (full sample size: N = 546)

| | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Bedtime Routine Inconsistency | 1.00 | | | | | | | | | |
| 2. | Poor Quality Sleep Environment | .07 | 1.00 | | | | | | | | |
| 3. | Security Positive | −.05 | −.16** | 1.00 | | | | | | | |
| 4. | Security Negative | .12** | .07^ | −.10* | 1.00 | | | | | | |
| 5. | Family SES | −.11* | −.26** | .21** | .00 | 1.00 | | | | | |
| 6. | Sleep Duration | −.09^ | −.16** | .11* | −.04 | .14* | 1.00 | | | | |
| 7. | Sleep Timing | .22** | .22** | −.21** | .06 | −.20** | −.34** | 1.00 | | | |
| 8. | Sleep Variability | .20** | .18** | −.14** | .14** | −.13** | −.16** | .34** | 1.00 | | |
| 9. | Sleep Activity | .01 | .11* | −.04 | .05 | −.11* | −.32** | .05 | .26** | 1.00 | |
| 10. | Sleep Latency | .02 | .11* | .04 | .05 | .03 | −0.01 | .15** | .14** | .16** | 1.00 |
| | *N* | 502 | 539 | 546 | 546 | 536 | 444† | 444† | 443† | 444† | 440† |
| | *M* | 0.01‡ | 3.39 | 0.01‡ | 0.00‡ | 48.21 | −0.05‡ | −0.06‡ | 0.02‡ | 0.24‡ | 39.68 |
| | *SD* | 0.86 | 1.78 | 0.01 | 0.01 | 13.05 | 0.84 | 0.87 | 0.81 | 0.91 | 23.21 |

*Note:* Sleep variables, including Sleep Duration, Timing, Variability, and Activity, represent composites of several actigraphic variables. These composites, along with descriptive information about each of the included acitgraphic variables, are described in Table 1.

^ $p \leq .10$

* $p \leq .05$

** $p \leq .01$ – all two-tailed

† Smaller number of useable actigraphy cases were due to problems associated with actigraphy data collection, including technical failure of the device and loss/destruction of the actigraph while the family had the device.

‡ Denotes that this variable is either standardized or a standardized composite

**Table 3.**

Multiple regression analyses with sleep domains as outcomes and pre-bedtime indexes as predictors

| | β | *SE* | ***p*-value** |
|---|---|---|---|
| Sleep Duration | | | |
| Bedtime Routine Inconsistency | −.06 | .05 | .24 |
| Poor Quality Sleep Environments | −.12 | .02 | .02 |
| Security Positive | .08 | 9.15 | .12 |
| Security Negative | −.03 | 23.86 | .54 |
| Family SES | .09 | .003 | .08 |
| | $F(5,418) = 3.97$, $p = .001$, $R^2 = .03$ | | |
| Sleep Timing | | | |
| Bedtime Routine Inconsistency | .18 | .05 | <.001 |
| Poor Quality Sleep Environments | .15 | .02 | .002 |
| Security Positive | −.14 | 9.12 | .002 |
| Security Negative | .02 | 23.79 | .73 |
| Family SES | −.11 | .003 | .03 |
| | $F(5,418) = 11.30$, $p < .001$, $R^2 = .11$ | | |
| Sleep Variability | | | |
| Bedtime Routine Inconsistency | .17 | .04 | <.001 |
| Poor Quality Sleep Environments | .13 | .02 | .01 |
| Security Positive | −.07 | 8.71 | .14 |
| Security Negative | .10 | 22.72 | .05 |
| Family SES | −.07 | .003 | .15 |
| | $F(5,430) = 7.88$, $p < .001$, $R^2 = .08$ | | |

*Note:* SES = socioeconomic status

## Table 4.

Results of post-hoc cross-sectional mediation analyses with unstandardized indirect effects

| IV | Mediator | DV | Significant Mediation? | Indirect Effect |
|---|---|---|---|---|
| Family SES | Bedtime Routine Consistency | Sleep Duration | No | Direct Effect: $B = .008$, $p = .01$ |
| | | | | Indirect Effect: $B = .001$, $p > .05$ |
| | | | | Prop. Mediated: $B = .06$, $p > .05$ |
| **Family SES** | **Poor Quality Sleep Environment** | **Sleep Duration** | **Yes** | Direct Effect: $B = .007$, $p = .03$ |
| | | | | Indirect Effect: $B = .002$, $p < .01$ |
| | | | | Prop. Mediated: $B = .22$, $p = .004$ |
| **Family SES** | **Security Positive** | **Sleep Duration** | **Yes** | Direct Effect: $B = .008$, $p = .01$ |
| | | | | Indirect Effect: $B = .001$, $p = .04$ |
| | | | | Prop. Mediated: $B = .14$, $p = .05$ |
| **Family SES** | **Bedtime Routine Consistency** | **Sleep Timing** | **Yes** | Direct Effect: $B = -.01$, $p < .001$ |
| | | | | Indirect Effect: $B = -.002$, $p < .01$ |
| | | | | Prop. Mediated: $B = .14$, $p = .006$ |
| **Family SES** | **Poor Quality Sleep Environment** | **Sleep Timing** | **Yes** | Direct Effect: $B = -.01$, $p < .001$ |
| | | | | Indirect Effect: $B = -.003$, $p < .001$ |
| | | | | Prop. Mediated: $B = .21$, $p < .001$ |
| **Family SES** | **Security Positive** | **Sleep Timing** | **Yes** | Direct Effect: $B = -.01$, $p < .001$ |
| | | | | Indirect Effect: $B = -.002$, $p < .001$ |
| | | | | Prop. Mediated: $B = .17$, $p < .001$ |
| **Family SES** | **Bedtime Routine Consistency** | **Sleep Variability** | **Yes** | Direct Effect: $B = -.007$, $p = .02$ |
| | | | | Indirect Effect: $B = -.002$, $p < .001$ |
| | | | | Prop. Mediated: $B = .18$, $p = .01$ |
| **Family SES** | **Poor Quality Sleep Environment** | **Sleep Variability** | **Yes** | Direct Effect: $B = -.006$, $p > .05$ |
| | | | | Indirect Effect: $B = -.002$, $p = .004$ |
| | | | | Prop. Mediated: $B = .25$, $p = .02$ |
| **Family SES** | **Security Positive** | **Sleep Variability** | **Yes** | Direct Effect: $B = -.006$, $p = .03$ |
| | | | | Indirect Effect: $B = -.001$, $p = .02$ |
| | | | | Prop. Mediated: $B = .18$, $p = .03$ |

*Note:* SES = socioeconomic status; Prop. Mediated = the proportion of the effect of the IV on the DV that is explained by the mediator

Significance testing computed using bootstrapping procedures. Bolded text indicates significant mediation models.