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# Screen Use before Bedtime: Consequences for Nighttime Sleep in Young Children

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## Abstract

There is increasing interest in the relation between screen use and sleep problems in early childhood. In a sample of 30-month-old children, this study used observational measures of screen use during the hour or so leading up to bedtime, parent reports of screen use during the child's bedtime routine, and actigraphic measures of toddler sleep to complement parent-reported sleep problems. Whether screen use was observed during the pre-bedtime period or was reported by the parents as part of the nightly bedtime routine, greater screen use in either context was associated with more parent-reported sleep problems. Additionally, more frequent parent-reported screen use during the bedtime routine was also associated with actigraphic measures of later sleep, shorter sleep, and more night-to-night variability in duration and timing of sleep. These associations suggest the negative consequences of screen use for children's sleep extend both to aspects of sleep reported by parents (e.g., bedtime resistance, signaled awakenings) and to aspects measured by actigraphy (e.g., shorter and more variable sleep).

### Keywords

sleep; screen use; early childhood; bedtime routines; actigraphy

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## 1. Introduction

Screen use is pervasive for young children of the current culture. In a nationally representative survey of U.S. parents, 88% of children between age 2 and 3 years spent an average of 2 hours per day using technology with screens (Rideout et al., 2006). Most screen use at this age (72%) involved watching television, videos, or DVDs, with fewer than 5% of parents reporting their child used a computer or played video games on either a console or handheld device. In a 2013 update, children between 2 and 3 years continued to use screens for 2 hours per day, primarily through television (1.75 hours) with tablet use increasing to about 15 minutes per day (Rideout, 2013).

With the proliferation of smartphones, tablets, and handheld gaming devices, there is increasing interest in the relation between screen use and sleep problems in early childhood. Two recent systematic reviews of research with children from birth to age 5 (Janssen et al., 2020; Newton et al., 2020) found that greater screen use was associated with later bedtimes, longer sleep onset latency, shorter sleep duration, more nighttime awakenings, and more parent-reported sleep problems. Though the findings were consistent, there were only enough studies (birth to age 5 $N = 9$; toddlers = 4) to conduct a meta-analysis of total daily screen use and sleep duration (Janssen et al., 2020). For toddlers, there was a small association ($r = -.13$), suggesting that increased total screen use was related to shorter sleep duration. A longitudinal study included in the meta-analysis by Janssen and colleagues (2020) estimated that each additional hour of TV was associated with 7 fewer minutes of sleep per day (Cespedes et al., 2014).

Considering the predominance of screen use in modern culture, the literature on screen use and sleep problems in young children is still relatively sparse and has primarily relied on parent-reports of both screen use and sleep problems. Parent reports of sleep are more likely to provide an accurate reflection of sleep behaviors that are readily observable, such as bedtime resistance, signaled nighttime awakenings, and time spent in bed, compared to parent reports on other features of sleep, including sleep onset latency and non-signaled nighttime awakenings (Werner et al., 2008). Existing evidence of an association between higher levels of screen use and poor sleep may have been limited thus far to sleep behaviors that are more disruptive to parents and, thus, more readily reported.

A further methodological point to be considered in interpreting the association between screen use and sleep is that most of the studies included in the recent reviews of screen use and sleep (Janssen et al., 2020; Newton et al., 2020) used reports of average *daily* screen use ($n = 10$); only five studies evaluated the relation between *evening* screen use and nighttime sleep. Screen use prior to bedtime is thought to disrupt natural circadian rhythms due to increased exposure to light during evening hours (Wood et al., 2013). Thus, it is reasonable to expect the negative consequences of screen use for sleep to be amplified with longer duration of use and greater proximity to bedtime. Indeed, for 3- to 5-year-old children, longer average daily use of television and tablets in the evening is predictive of more parent-reported bedtime resistance and shorter sleep durations, even with controls for demographic differences (Nathanson & Beyens, 2018). A subsequent analysis (Beyens & Nathanson, 2019) of the same sample suggested that longer average evening screen use (television and

mobile devices) was predictive of later bedtimes, later rise times, and a lower percentage of sleep at night per 24-hour period.

Screen use may be associated with poor sleep for a variety of reasons. Possible mechanisms include a) children having less time for sleep due to more time spent using screens (Cespedes et al., 2014), b) the arousing properties of content viewed on screens making it more difficult for children to fall asleep (Hale & Guan, 2015), and c) blue light from screens interfering with circadian rhythms (possibly by reducing melatonin production; Wood et al., 2013) leading to increases in sleep onset latency and shortened nighttime sleep durations (Xie et al., 2017).

The current study used observational measures of screen use during the hour or so leading up to bedtime (the pre-bedtime period) from one home visit, parent-reported screen use as part of the child's bedtime routine across one week, and actigraphic measures of toddler sleep to complement parent reports. First, we expected that more frequent observed screen use during the hour leading up to bedtime would be associated with poorer sleep. Second, we hypothesized that the association with poorer sleep would be stronger with reported screen use as part of the bedtime routine. Third, we hypothesized that there would be group differences in sleep-relative screen use. We expected that children who were observed to use screens during the pre-bedtime period, or who were reported to use screens as part of their bedtime routine, would experience worse sleep compared to children who did not use screens in either context. Finally, as the focus of this study was the relation between screen use and nighttime sleep, we also hypothesized that there would be less sleep consolidation (i.e., percentage of sleep per 24-hour period occurring at night) with greater screen use both as observed during the pre-bedtime period and in relation to reported use during the bedtime routine.

## 2. Methods

### 2.1. Participants

Data for this study were drawn from a larger study ($N$ = 611; collected between 2007 and 2017) of sleep and self-regulation. Children were included in the current study if they participated in a pre-bedtime observation and had actigraphic sleep data ($N$ = 474; 78% of families). Participants were recruited from two mid-sized Midwestern cities (Site 1 = 295; Site 2 = 179) through county birth records, community organizations (e.g., Head Start, local Housing Authority), and public advertisements (e.g., flyers, postcards). Children were excluded from participating in the study if they had severe developmental delays. Parents were compensated for their time, and children were given small gifts for wearing their actigraph each night. Institutional Review Boards at both sites approved of all procedures.

Children (male = 257; female = 217) were within two-weeks of 30 months of age, and were from predominantly two-parent (85%, 8% single parent, 5% other, 2% not reported), college educated (73% college degree, 21% some college, 4% high school diploma or less, 2% not reported) households and were majority Caucasian (89%, 4% Latino, 2% Black, 2% Asian, 1% Mixed Race, and 1% unknown, not reported, or missing). Based on parent education and

occupation, household SES ranged from 12.5 to 66, with ($M$ = 48.41; $SD$ = 13.08) (Hollingshead, 1975).

## 2.2. Procedure

At a first home visit, parents were given sleep diaries, actigraphs, and small gifts that they could give to their child each morning along with several questionnaires. During a second home visit several days later, two trained research assistants observed the family during the pre-bedtime period, the hour before the start of the child's typical bedtime routine. Upon arriving at the home, researchers gave the child a gift, received a tour of the child's sleeping place as well as any area the family typically spent time prior to the child's bedtime (e.g., kitchen, living room). Parents wore a microphone that enabled the observers to hear interactions occurring in rooms that they did not enter. The researchers then made themselves as unobtrusive as possible while taking detailed, narrative-style notes on the events leading up to the child going to bed. Within 24-hours of the home visit, researchers created electronic versions of their notes, adding details and clarifying information when needed.

## 2.3. Measures

### 2.3.1. Screen Use

**2.3.1.1. Observed Screen Use during the Pre-bedtime Period.:** A text analysis was performed on the narrative-style notes from the pre-bedtime observation. A "screen use" dictionary, containing words pertaining to electronic screens with which children typically engage (e.g., tablet, computer), was created (total number of words in the dictionary $N$ = 18; dictionary available upon request). Words in this dictionary were formatted to identify common word variants (e.g., tv and television). Each home visit narrative was examined using The Simple Natural Language Processing Tool (SiNLP; Crossley et al., 2014), a tool that allows users to analyze texts using customizable dictionaries. SiNLP calculated the proportion of words in each narrative that corresponded with the "screen use" dictionary. These values were then standardized.

**2.3.1.1. Reported Screen Use during the Bedtime Routine.:** On a nightly sleep diary ($M$ = 10.14 nights, $SD$ = 4.22), parents reported the activities of that night's bedtime routine (Appendix). Sleep diaries had prefilled activities that were either customized to reflect activities that parents stated were part of the child's regular bedtime routine (Site 1) or the diaries employed a set of six standard (non-customized) steps, including TV (Site 2). At both sites, sleep diaries had blank spaces for parents to report additional activities. For the purposes of this study, screen use was coded as "present" if it was reported on at least one night (prefilled or added). Otherwise, it was coded as "not present". The proportion of nights ($M$ = 0.20, median = 0.07, minimum = 0, maximum = 1) with reported screen use was computed based on the total nights for which diary information was available.

**2.3.2. Sleep—**Children wore an actigraph (a watch-like device; MicroMini Motionlogger from Ambulatory Monitoring, Inc., Ardsley, NY) for one to two weeks ($M$ = 10.14 nights, $SD$ = 4.22). Using daily sleep diaries, primary caregivers reported bedtime, nighttime awakenings, and rise times as well as reasons the actigraph was not worn. Actigraph data

were scored with Action W2 software (AW2; version 2.6.92 Ambulatory Monitoring, Inc.). Watches recorded activity as the number of times per second the watch crossed the zero-axis per one-minute interval (1 Hz sample rate), which was used to estimate sleep versus wake states using a well-validated sleep algorithm for children (Sadeh et al., 1994).

To obtain more reliable estimates of actigraphic and sleep diary variables, individual variables were first averaged across nights (Acebo et al., 1999). Sleep variables were then standardized and averaged into conceptually and empirically relevant, multi-variable composites (Staples et al., 2019). Sleep composites were selected over individual variables to reduce the possibility of spurious findings while retaining indices of the major sleep areas of duration, timing, variability, and activity. Sleep Duration was the average of the actigraph variables sleep period (duration from sleep onset to sleep offset), sleep opportunity (diary reported bedtime to actigraph determined morning awakening), and minutes asleep. Sleep Timing was the average of bedtime (diary), sleep onset (actigraph), and midsleep (actigraph). Sleep Variability was the average of night-to-night standard deviations of sleep onset, bedtime (diary), midsleep, sleep opportunity, sleep period, and total minutes asleep. Sleep Activity was the average of (all actigraph) average time awake, variability in minute-to-minute activity level, average number of awakenings lasting 5 or more minutes, average duration of longest wake episode, and average percent of active epochs. Sleep onset latency was the average time to fall asleep from caregiver reported bedtime to actigraph-determined sleep onset. Sleep Consolidation was the average percentage of sleep per 24-hour period that occurred at night. Parent-reported sleep problems were obtained from a modified version of the Children's Sleep Habits Questionnaire (Owens et al., 2000) where higher scores reflect more sleep problems.

### 2.4. Statistical analysis

Analyses were performed with R version 3.6.1 (R Core Team, 2019) using the psych (Revelle, 2019) and car (Fox & Weisberg, 2019) packages. To test the first two hypotheses, Pearson correlation values were computed to examine the strength of the association between sleep and screen use. To test hypothesized group differences based on screen use, sleep variables were considered in relation to the presence or absence of *observed* screen use during the pre-bedtime period and, separately, in relation to *reported* screen use during the bedtime routine. For observed screen use during the pre-bedtime period, Welch's *t*-tests were used to account for unequal sample sizes and heterogeneity. The *t*-tests are presented for the sake of parsimony, but additional, multiple regression analyses with controls for household SES and child sex along with the observed/reported screen use as predictors resulted in the same pattern of findings with respect to group differences in sleep. Finally, to address violations of the statistical assumption of normality for each of the *t*-tests, a bootstrap resampling procedure was used to estimate the group differences from 1,000 resamples of the data. Based on the 1,000 estimated parameters, a 95% confidence interval was constructed from the values of the estimated parameters at the 2.5 and 97.5 percentiles. The results from the bootstrap resampling procedure were consistent with the reported statistical tests.

## 3. Results

Bivariate Pearson correlation coefficients between screen use and sleep variables are listed in Table 1. Greater observed screen use (*z*-scored proportions) during the pre-bedtime period was associated with more frequent reported screen use during the bedtime routine, later sleep timing, and more parent-reported sleep problems. More frequent reported screen use during the bedtime routine was associated with shorter actigraphic Sleep Duration, later Sleep Timing, more Sleep Variability, later sleep onset latency, as well as more parent-reported sleep problems. The actigraphic sleep composites were generally statistically significantly associated with one another, but to a small to moderate degree. Shorter Sleep Duration was associated with later Sleep Timing, greater Sleep Variability, and more Sleep Activity. Later Sleep Timing was associated with more Sleep Variability that, in turn, was associated with more Sleep Activity. Longer sleep onset latency was associated with later Sleep Timing, more Sleep Variability, and greater Sleep Activity. More parent-reported sleep problems were associated with shorter Sleep Durations, later Sleep Timing, more Sleep Variability, and more Sleep Activity. Higher household SES was associated with less observed screen use prior to bedtime, greater Sleep Duration, earlier Sleep Timing, less Sleep Variability, less Sleep Activity, and fewer parent-reported sleep problems. Finally, girls had longer Sleep Duration and more consolidated sleep than boys.

Table 2 contains descriptive statistics and *t*-test information comparing sleep variables for children who were observed to use screens (80%) to children who were not (20%). Children observed to use screens during the pre-bedtime period also had more frequent reported screen use during the bedtime routine, had later Sleep Timing, and less sleep consolidation compared to children not observed to use screens during the pre-bedtime period.

Although screen use during the pre-bedtime period was observed for most children, parents reported screen use during the bedtime routine on at least one night for only half of the sample. Table 3 contains descriptive statistics and *t*-test information comparing household SES, child sex, and sleep variables for children whose parents did and did not report screen use during the bedtime routine on at least one night. Children with reported screen use during the bedtime routine had shorter Sleep Durations and more Sleep Variability compared to children without reported screen use during the bedtime routine.

## Discussion

To our knowledge, this is the first study to examine observed measures of screen use during the pre-bedtime period in relation to both actigraphic and parent-reported nighttime sleep in young children. Whether screen use was observed during the pre-bedtime period or reported as part of the bedtime routine by the parent, the findings were consistent: greater screen use was associated with more parent-reported sleep problems. Additionally, actigraphy showed that children who were observed to use screens during the pre-bedtime period had later sleep timing and less consolidated sleep compared to children who were not observed to use screens during the pre-bedtime observation. These results are consistent with the hypothesis that spending time using screens in the evening results in less time for nighttime sleep.

The associations between actigraphic measures of sleep and parent-reported screen use as part of the bedtime routine suggests possible reasons for the connections between parent-reported sleep problems and screen use found in this and other studies (Janssen et al., 2020; Newton et al., 2020). It is possible that screen use as part of the bedtime routine reflects some degree of inconsistency in the bedtime routine. Research has shown that a consistent bedtime routine is associated with earlier bedtimes, longer sleep duration, and fewer nighttime awakenings (Mindell et al., 2015). In this sample, screen use was rarely a regular part of the bedtime routine with less than 4% ($n = 17$) of parents reporting nightly screen use during the bedtime routine. Among those reporting screen use during the bedtime routine, most parents (71%) reported using screens during the bedtime routine on less than half of the nights. If consistency of the bedtime routine promotes better sleep, then we would expect that even infrequent inclusion of screen use in the bedtime routine would be problematic for children's sleep. Consistent with this expectation, we found that more frequent parent-reported screen use during the bedtime routine was also associated with actigraphic measures of later sleep, shorter sleep, and more variable duration and timing of sleep from night-to-night. Notably, these associations were with actigraphic measures of sleep, which suggests the negative consequences of screen use for children's sleep extend beyond those aspects of sleep that were reported by parents (e.g., bedtime resistance, signaled awakenings).

Contrary to expectations, we found that when parents endorsed more frequent screen use during the bedtime routine, children tended to fall asleep more quickly. One possible explanation for this finding is that children with screen use as a part of their bedtime routine are going to bed later and are consequently more tired, resulting in shorter sleep onset latency. Another possibility is that parents who allowed their children to use screens at bedtime may have been unsure about how to report down time on the sleep diary. For example, the child may have been in bed for an hour, but the parent did not record the bedtime until the show was over, which could result in a falsely short sleep onset latency. This could not be addressed by the current study, so there is also a need for research to clarify the extent to which parents may or may not consider screen use during the pre-bedtime period as an explicit part of their child's bedtime routine. More broadly, additional research is needed to determine whether the link between screen use and shorter sleep onset latency reflects later bedtimes on screen-use-nights, inconsistencies in how parents report screen use near the time of sleep onset, or some combination of these and other factors.

Although the associations between screen use and sleep differed based on whether screen use was observed during the pre-bedtime period or was reported by the parents as part of the nightly bedtime routine, greater screen use in either context was associated with more parent-reported sleep problems. When considering actigraphic measures of sleep, more frequent parent-reported screen use during the bedtime routine was associated with shorter, later, and more variable sleep. When parents report screen use as part of their child's bedtime routine, this implies that screen use is intentional and planned, potentially to facilitate the child's transition to sleep. The present findings, however, indicate that such exposure to screens as part of the bedtime routine is disruptive to children's sleep. We interpret this finding as support for clinical recommendations that screen use should be avoided in the bedtime routine to facilitate good sleep hygiene, melatonin secretion, and

healthy sleep onset associations at bedtime. Clinicians have often observed that children who learn to fall asleep with screens at bedtime may come to rely on this stimulation to return to sleep after waking in the night, which may result in poor sleep efficiency (Bathory & Tomopoulos, 2017). It is argued that children who learn to fall asleep independently and without screens are more likely to return to sleep independently and without screens in the middle of the night. The findings from the current study are consistent with previous research showing that screen use increases arousal, making it difficult to fall asleep (Hale & Guan, 2015) and that screen use results in less melatonin production (Wood et al., 2013), which increases sleep onset latency and shortens nighttime sleep duration (Xie et al., 2017).

There are, however, several limitations related to the sample and measurement of screen use. First, the cross-sectional and relatively demographically homogeneous sample limits the generalizability of the findings. Future research is needed to see if these findings replicate longitudinally, particularly with actigraphic measures of sleep. There is also a need to study more ethnically and racially diverse samples. Longitudinal evidence suggests that while screen use was consistently linked with shorter sleep duration from infancy through age 8, these negative effects of screen use were larger for children from minority backgrounds (Cespedes et al., 2014). Second, we were not able to separate screen use into activities that may be more passive (e.g., watching TV) versus those that may be more interactive (e.g., playing a videogame) from either the home observation or sleep diaries. Though research suggests that 30-month-old children are more likely to engage in passive than interactive screen use (Rideout, 2013), future research is needed to determine whether the way children interact with screens is also consequential for their sleep.

Despite these limitations, this study makes a substantial contribution to the fields of child development, sleep research, and pediatric behavioral sleep intervention because it is the first of its kind to use actigraphic and observed measures in addition to parent report measures and to specifically account for pre-bedtime screen use. With these rich and diverse measures, we reliably found that more screen use was associated with poorer sleep. This is important given the predominance of screen use in modern culture and the importance of sleep for children’s socioemotional adjustment, physical health, and academic performance.

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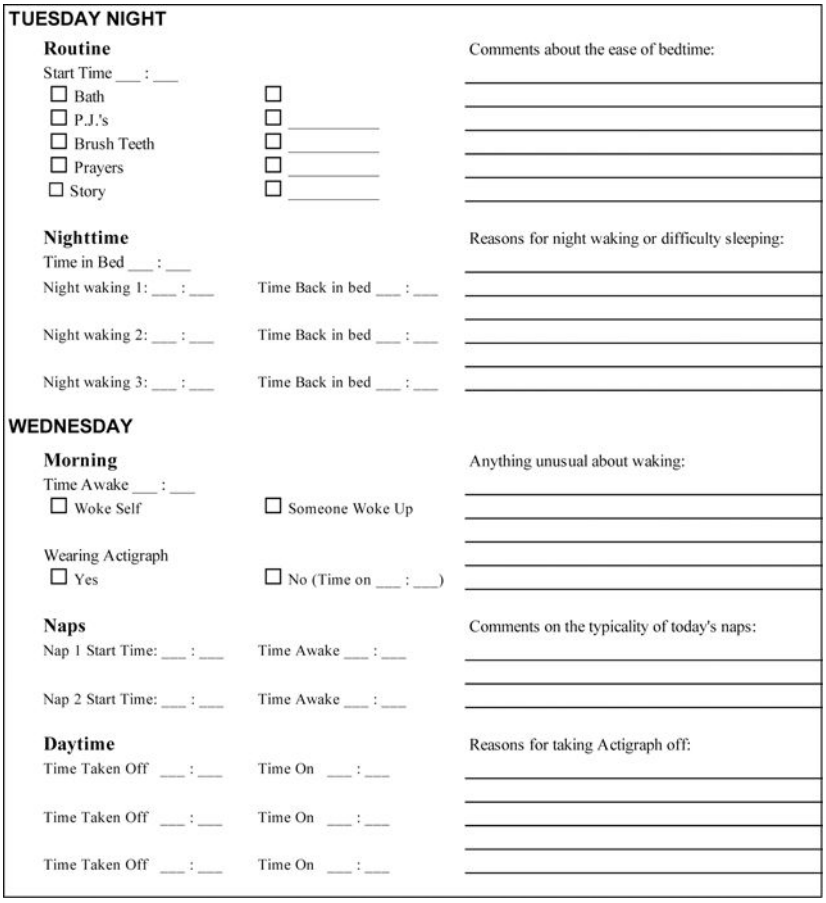
## Appendix



**TUESDAY NIGHT**

**Routine**

Start Time ___ : ___

☐ Bath ☐

☐ P.J.'s ☐ _____

☐ Brush Teeth ☐ _____

☐ Prayers ☐ _____

☐ Story ☐ _____

Comments about the ease of bedtime:

**Nighttime**

Time in Bed ___ : ___

Night waking 1: ___ : ___ Time Back in bed ___ : ___

Night waking 2: ___ : ___ Time Back in bed ___ : ___

Night waking 3: ___ : ___ Time Back in bed ___ : ___

Reasons for night waking or difficulty sleeping:

**WEDNESDAY**

**Morning**

Time Awake ___ : ___

☐ Woke Self ☐ Someone Woke Up

Wearing Actigraph

☐ Yes ☐ No (Time on ___ : ___)

Anything unusual about waking:

**Naps**

Nap 1 Start Time: ___ : ___ Time Awake ___ : ___

Nap 2 Start Time: ___ : ___ Time Awake ___ : ___

Comments on the typicality of today's naps:

**Daytime**

Time Taken Off ___ : ___ Time On ___ : ___

Time Taken Off ___ : ___ Time On ___ : ___

Time Taken Off ___ : ___ Time On ___ : ___

Reasons for taking Actigraph off:

## References


Acebo C, Sadeh A, Seifer R, Tzischinsky O, Wolfson AR, Hafer A, & Carskadon MA (1999). Estimating sleep patterns with activity monitoring in children and adolescents: How many nights are necessary for reliable measures? Sleep, 22(1), 95–103. 10.1016/0029-7844(94)00457-O [PubMed: 9989370]

Bathory E, & Tomopoulos S (2017). Sleep regulation, physiology and development, sleep duration and patterns, and sleep hygiene in infants, toddlers, and preschool-age children. Curr Probl Pediatr Adolesc Health Care, 47(2), 29–42. 10.1016/j.cppeds.2016.12.001 [PubMed: 28117135]

Beyens I, & Nathanson AI (2019). Electronic media use and sleep among preschoolers: Evidence for time-shifted and less consolidated sleep. Health Communication, 34(5), 537–544. 10.1080/10410236.2017.1422102 [PubMed: 29323943]

Cespedes EM, Gillman MW, Kleinman K, Rifas-Shiman SL, Redline S, & Taveras EM (2014). Television viewing, bedroom television, and sleep duration from infancy to mid-childhood. Pediatrics, 133(5). 10.1542/peds.2013-3998

Crossley SA, Allen LK, Kyle K, & McNamara DS (2014). Analyzing discourse processing using a simple natural language processing tool. In Discourse Processes (Vol. 51, Issues 5–6, pp. 511–534). Taylor & Francis. 10.1080/0163853X.2014.910723

Fox J, & Weisberg S (2019). An R Companion to Applied Regression, Third Edition. Thousand Oaks CA: Sage. https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Hale L, & Guan S (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. Sleep Med Rev, 21, 50–58. 10.1016/j.smrv.2014.07.007 [PubMed: 25193149]

Janssen X, Martin A, Hughes AR, Hill CM, Kotronoulas G, & Hesketh KR (2020). Associations of screen time, sedentary time and physical activity with sleep in under 5s: A systematic review and meta-analysis. Sleep Medicine Reviews, 49, 101226. 10.1016/j.smrv.2019.101226 [PubMed: 31778942]

Mindell JA, Li AM, Sadeh A, Kwon R, & Goh DYT (2015). Bedtime routines for young children: A dose-dependent association with sleep outcomes. Sleep, 38(5), 717–722. 10.5665/sleep.4662 [PubMed: 25325483]

Nathanson AI, & Beyens I (2018). The relation between use of mobile electronic devices and bedtime resistance, sleep duration, and daytime sleepiness among preschoolers. Behavioral Sleep Medicine, 16(2), 202–219. 10.1080/15402002.2016.1188389 [PubMed: 27323239]

Newton AT, Honaker SM, & Reid GJ (2020). Risk and protective factors and processes for behavioral sleep problems among preschool and early school-aged children: a systematic review. Sleep Medicine Reviews, 52, 1–19. 10.1016/j.smrv.2020.101303

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(8), 1043–1051. 10.1111/j.1469-8749.2001.tb00204.x [PubMed: 11145319]

R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Revelle W (2019) psych: Procedures for personality and psychological research (v. 1.9.12), Northwestern University, Evanston, Illinois, USA, http://CRAN.Rproject.org/package=psych

Rideout VJ (2013). Zero to eight: Children's media use in America 2013. In Common Sense Media. 10.1111/j.1749-6632.1994.tb44091.x

Rideout VJ, Hamel E, & Kaiser FF (2006). The media family: Electronic media in the lives of infants, toddlers, preschoolers and their parents. The Henry J. Kaiser Family Foundation, 1–35.

Sadeh A, Sharkey M, & Carskadon MA (1994). Activity-based sleep-wake identification: An empirical test of methodological issues. Sleep, 17, 201–207. 10.1093/sleep/17.3.201 [PubMed: 7939118]

Staples AD, Bates JE, Petersen IT, McQuillan ME, & Hoyniak C (2019). Measuring sleep in young children and their mothers: Identifying actigraphic sleep composites. International Journal of Behavioral Development, 43(3), 278–285. 10.1177/0165025419830236 [PubMed: 31673196]

Werner H, Molinari L, Guyer C, & Jenni OGG (2008). Agreement rates between actigraphy, diary, and questionnaire for children's sleep patterns. Archives Of Pediatrics & Adolescent Medicine, 162(4), 350–358. 10.1001/archpedi.162.4.350 [PubMed: 18391144]

Wood B, Rea MS, Plitnick B, & Figueiro MG (2013). Light level and duration of exposure determine the impact of self-luminous tablets on melatonin suppression. Applied Ergonomics, 44(2), 237–240. 10.1016/j.apergo.2012.07.008 [PubMed: 22850476]

Xie Z, Chen F, Li WA, Geng X, Li C, Meng X, Feng Y, Liu W, & Yu F (2017). A review of sleep disorders and melatonin. Neurological Research, 39(6), 559–565. 10.1080/01616412.2017.1315864 [PubMed: 28460563]

## Highlights

- 80% of 30-month-olds were observed to use screens in the hour before bedtime
- 50% of children had screens as part of their bedtime routine on at least one night
- Evening and bedtime screen use was related to more parent-reported sleep problems
- Sleep differed with just one night of screen use at the bedtime routine
- Screen use as part of a bedtime routine was associated with poorer nighttime sleep

**Table 1.**

Bivariate Pearson Correlation Coefficients between Screen Use, Sleep Variables, Household SES, and Child Sex

| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Observed pre-bedtime screen use | .42*** | −.06 | .16** | .08 | −.03 | −.01 | −.06 | .13* | −.11* | −.08 |
| 2. Reported bedtime routine screen use | 1.00 | −.11* | .10* | .12* | .02 | −.10* | −.02 | .15** | −.09 | −.03 |
| 3. Sleep Duration | | 1.00 | −.34*** | −.16** | −.38*** | −.05 | .34*** | −.32*** | .17** | .12* |
| 4. Sleep Timing | | | 1.00 | .35*** | .07 | .20*** | −.07 | .25*** | −.17*** | .01 |
| 5. Sleep Variability | | | | 1.00 | .26*** | .16** | .04 | .21*** | −.14** | .04 |
| 6. Sleep Activity | | | | | 1.00 | .19*** | −.06 | .12* | −.12* | −.10 |
| 7. Sleep onset latency | | | | | | 1.00 | −.19*** | −.06 | −.01 | .00 |
| 8. Sleep consolidation | | | | | | | 1.00 | .02 | −.06 | .13* |
| 9. CSHQ sleep problems | | | | | | | | 1.00 | −.14** | .03 |
| 10. Hollingshead SES | | | | | | | | | 1.00 | −.01 |
| 11. Child sex: female | | | | | | | | | | 1.00 |

*Note.* Children's Sleep Habits Questionnaire (CSHQ) reflects caregiver reported sleep problems. Household SES was based on parent education and occupation (Hollingshead, 1975). Child sex was coded as male = 0, female =1 and a statistically significant Pearson *r*−value is equivalent to a *t*-test of mean-level differences for each sleep variable.

* $p < .05$

** $p < .01$

*** $p < .001$ (two-tailed)

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**Table 2.**

Observed Screen Use during the Pre-Bedtime Period: Descriptive Statistics and Group Comparisons

| | Observed Screen Use during Pre-bedtime | | | | | | |
|---|---|---|---|---|---|---|---|
| | No Screen Use (*n* = 85) | | | Screen Use (*n* = 389) | | | Welch's *t*-tests |
| **Variable** | **n** | **Mean** | **SD** | **n** | **Mean** | **SD** | **p** |
| Household SES | 80 | 49.29 | 13.74 | 376 | 48.11 | 12.99 | .48 |
| Child sex: female | 85 | 0.52 | 0.50 | 388 | 0.45 | 0.50 | .23 |
| Screen: Bedtime routine | 83 | 0.10 | 0.17 | 384 | 0.23 | 0.31 | < .001 |
| Sleep Composites | 68 | 0.15 | 0.86 | 326 | −0.06 | 0.83 | .07 |
| Sleep Duration | | | | | | | |
| Sleep Timing | 68 | −0.45 | 0.72 | 326 | 0.00 | 0.87 | < .001 |
| Sleep Variability | 68 | −0.09 | 0.69 | 326 | 0.05 | 0.86 | .17 |
| Sleep Activity | 68 | 0.14 | 1.03 | 326 | 0.23 | 0.90 | .50 |
| Sleep onset latency (min) | 68 | 33.82 | 22.64 | 326 | 39.64 | 22.14 | .06 |
| Sleep consolidation (%) | 68 | 91.61 | 6.01 | 326 | 89.21 | 5.77 | < .01 |
| CSHQ Sleep Problems | 58 | 20.05 | 7.00 | 292 | 21.48 | 6.88 | .16 |

*Note.* Household socioeconomic status (SES). Child sex was coded as male = 0, female =1. Children's Sleep Habits Questionnaire (CSHQ) reflects caregiver reported sleep problems.

**Table 3.**

Reported Screen Use during the Bedtime Routine: Descriptive Statistics and Group Comparisons

| | Screen Use during Bedtime Routine | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 nights | | | 1 or more nights | | | *t*-tests |
| **Variable** | **n** | **Mean** | **SD** | **n** | **Mean** | **SD** | **p** |
| Household SES | 221 | 48.32 | 13.65 | 228 | 48.26 | 12.44 | .96 |
| Child sex: female | 217 | 0.45 | 0.50 | 256 | 0.47 | 0.50 | .66 |
| Sleep Composites Sleep Duration | 194 | 0.06 | 0.85 | 194 | −0.12 | 0.82 | .04 |
| Sleep Timing | 194 | −0.15 | 0.88 | 194 | 0.01 | 0.84 | .07 |
| Sleep Variability | 194 | −0.09 | 0.69 | 194 | 0.14 | 0.93 | < .01 |
| Sleep Activity | 194 | 0.24 | 0.94 | 194 | 0.20 | 0.90 | .67 |
| Sleep onset latency (min) | 194 | 39.94 | 22.94 | 194 | 37.69 | 21.70 | .32 |
| Sleep Consolidation (%) | 194 | 90.01 | 5.78 | 194 | 89.24 | 5.93 | .19 |
| CSHQ Sleep Problems | 158 | 20.04 | 6.59 | 187 | 22.24 | 7.00 | < .01 |

*Note*. Household socioeconomic status (SES). Child sex was coded as male = 0, female =1. Children's Sleep Habits Questionnaire (CSHQ) reflects caregiver reported sleep problems.