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Interactive vs passive screen time and nighttime sleep duration among school-aged children

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Abstract

Background—Insufficient sleep among school-aged children is a growing concern, as numerous studies have shown that chronic short sleep duration increases the risk of poor academic performance and specific adverse health outcomes. We examined the association between weekday nighttime sleep duration and 3 types of screen exposure: television, computer use, and video gaming.

Methods—We used age 9 data from an ethnically diverse national birth cohort study, the Fragile Families and Child Wellbeing Study, to assess the association between screen time and sleep duration among 9-year-olds, using screen time data reported by both the child (n = 3269) and by the child's primary caregiver (n= 2770).

Results—Within the child-reported models, children who watched more than 2 hours of television per day had shorter sleep duration by approximately 11 minutes per night compared to those who watched less than 2 hours of television ($\beta = -0.18$; $P < .001$). Using the caregiver-reported models, both television and computer use were associated with reduced sleep duration. For both child- and parent-reported screen time measures, we did not find statistically significant differences in effect size across various types of screen time.

Conclusions—Screen time from televisions and computers is associated with reduced sleep duration among 9-year-olds, using 2 sources of estimates of screen time exposure (child and parent reports). No specific type or use of screen time resulted in significantly shorter sleep duration than another, suggesting that caution should be advised against excessive use of all screens.

Keywords

Sleep; Screentime; Media; Televison; Computer; Video games; Pediatrics; Bedtime

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Disclosure

The other authors have nothing to disclose.

Introduction

Insufficient sleep among school-aged children is associated with an increased risk of poor academic performance,[1–4] obesity,[5–9] and depression.[10–13] Furthermore, if short sleep duration continues throughout childhood, its associations with heightened depressive symptoms and low self-esteem strengthen.[14] Inadequate sleep duration among young children and adolescents in the United States is common and growing.[15] According to the 2014 National Sleep Foundation poll, 31% of school-aged children aged 6 to 11 years receive less than the recommended 9 hours of sleep.[16]

The overwhelming majority of studies indicate that screen time or electronic media use is associated with lower sleep duration, delayed bedtimes, or other sleep disturbances among school children.[17,18] American children between ages 8 and 18 years spend an average of 7 hours per day in front of a screen.[19,20] Results from the 2014 National Sleep Foundation poll found that 75% of school-aged children have at least 1 electronic device in their bedroom. This includes a television (45%), a music player (40%), a tablet or smartphone (30%), a video game (25%), or a computer (21%).[16] A study by Calamaro et al[21] found that children ages 6 to 11 years who have at least a television, a telephone, and a computer in their bedroom receive 45minutes less sleep, compared to those who have no technology devices in their bedroom. Congruently, Cespedes et al[22] analyzed screen time in a longitudinal study of 7-year-olds and found that each additional hour of television watching per day was associated with 6 minutes of shorter sleep duration. Another study found that among children aged 6 to 16 years, watching television and using the computer for more than 2 hours per day were both significantly associated with short sleep duration, with the effect size being greater for computer use.[23] Furthermore, among 10- and 11-year-olds, using a computer for 1 hour per day was associated with approximately 11 minutes less sleep per night on school nights over an 18-month period in another study.[24] Beyond the use of individual screen types, the effects of aggregate screen time have been studied. Drescher et al[25] measured the amount of time per day spent watching television, playing video or computer games, and using the Internet and found aggregate screen time to be significantly associated with shorter sleep duration among children younger than 13.3 years.

Previous scholars have hypothesized that interactive screen time, such as video gaming and Web surfing, is more likely to be disruptive to sleep than noninteractive screen time, such as watching television.[26] One such study showed that elementary school children who played video games or used the Internet at bedtime had significantly shorter weekday sleep duration compared to those who did not use video games or surf the Internet before bed, whereas no such association was reported among those who watched television at bedtime compared to those who did not watch television at bedtime.[27] However, there are very few studies that compare interactive and noninteractive screen time with regard to bedtime sleep duration, especially among school-aged children.[23,26,27] Studies often only provide results for 1 or 2 types of screen time at a time or use a combined measure of overall screen time. Furthermore, a majority of the evidence on screen time and sleep duration among children focuses on television and computer use and often does not include video gaming.[17] These results, among others, indicate that multiple types of media, ranging on a spectrum of interactivity, are associated with shorter sleep duration among school-aged children.[28–30]

In the present study, we analyzed the association between various types of screen time and average weekday sleep duration among a large national sample of 9-year-olds. Our data were novel in that we had both parent reports and child reports on screen time exposure and were able to separate out the different forms of screen types. We hypothesized that use of any form of electronic media would be negatively associated with sleep duration. Furthermore, we expected that the strength of the association would vary based on the level of interactivity of the screen type. More specifically, we hypothesized that interactive forms of screen time, such as computer use and video gaming, would be associated with shorter bedtime sleep duration compared to passive forms of screen time, such as watching television.

Methods

Participants

The data used in this study were collected in the Fragile Families and Child Wellbeing (FFCW) Study, conducted jointly by Princeton University's Center for Research on Child Wellbeing and Center for Health and Wellbeing, and the Columbia Population Research Center and The National Center for Children and Families at Columbia University. The FFCW is a longitudinal cohort study that has followed approximately 5000 children, born between 1998 and 2000, since birth. Data were collected in 20 cities with populations of at least 200,000 across the United States. The sample was designed to include a high number of unmarried parents and racial minorities, along with a high proportion of low socioeconomic status. Reichman et al[31] provide a complete description of the FFCW, including the research design and limitations.

Families were recruited at birth in hospitals, and mothers were screened for eligibility. The inclusion criteria to participate in the study entailed that (1) the mother intended to keep the focal child, (2) she was proficient enough in English or Spanish and healthy enough to answer the survey questions, and (3) the father was still alive. These inclusion criteria disqualified less than 5% of mothers. In addition, because of legal constraints, in approximately half of the hospitals, parents of the focal child had to be at least 18 years of age to be eligible to participate. However, this had only a minimal impact on the sample.[31]

Interviews were conducted at baseline with the mothers and fathers in person at the hospitals, and subsequent follow-up interviews were conducted over the telephone at 12, 36, and 60 months of age. The study was expanded for the age 9 wave of data and included interviews with the primary caregiver, the focal child, and the focal child's teacher, as well as in-home observations. At each wave, substantial information was collected regarding family structure and relationships, parent and child behavior, access to resources, physical and mental health and development, and home and school environment.

Measures

We used data from the primary caregiver (PCG) surveys and the child interview within the age 9 data. Sleep was reported as hours per night on weekdays by the PCG. General daily screen time, as reported by the PCG, was measured continuously from 0 to 16 hours per day

for both television and computer usage separately. Television use was reported as average time on both weekdays and weekends, whereas computer time was nonspecific regarding weekdays and weekends. We chose to only analyze duration of television watching on weekdays, to agree with the data on weekday sleep, along with using general duration of computer use.

In the child interview, the focal child self-reported his or her average time on weekdays using the computer for school work, using the computer for chatting, playing video games, and watching television or movies. Response options included (1) “half an hour or less,” (2) “more than half an hour but less than an hour,” (3) “1–2 hours,” and (4) “more than 2 hours.” Based on our assessment of the distribution of screen time and on our preliminary analyses showing that the lower 3 levels of screen time were not differentially associated with sleep duration, we dichotomized the screen time categories into less than or more than 2 hours per day, for each type of screen time. This cutoff is in agreement with the 2-hour daily limit on media use recommended by the American Academy of Pediatrics.[32]

Additional covariates obtained from the mother's survey at baseline included sex, race, parental relationship, and mother's education. Sex was categorized as male or female; race was categorized as white non-Hispanic, black non-Hispanic, Hispanic, or other; parental relationship was categorized as married, cohabiting, visiting, friendly, hardly talk, never talk, or unknown father; and mother's education was categorized as less than high school, equivalent to high school, some or technical college, and college graduate. Within parental relationship, we consolidated visiting and friendly and hardly talk, never talk, and unknown father. We also combined the categories of less than high school and education equivalent to high school, within the mother's education variable. We chose to combine these categories based on the distribution of the data and our initial analyses.

Finally, we merged the data and omitted cases that did not contain full information for all variables of interest. We omitted 1629 and 2128 cases from the child-reported and PCG-reported models, respectively. We retained 66.7% of the baseline sample for the child-reported model and 56.6% for the PCG-reported model. Given the relatively large sample size, we justify using listwise deletion because most of the variable means were the same for the included sample as for the omitted sample.[33] Furthermore, most of the missing data were from our dependent variable of sleep duration and our primary predictor variable of screen time use. Typically, there are limited benefits to imputing the outcome variable,[34] and we do not want to introduce additional measurement error for the screen time exposure measure. Within the child-reported model, there were no differences between groups for sleep duration, any screen time variables, sex, or mother's education. Within the PCG-reported models, weekday nighttime sleep duration was approximately 12 minutes less for the omitted group ($P < .001$). The omitted group also watched approximately 17 minutes more television per weekday ($P < .001$). However, there were no differences found between groups for hours of computer use. Within both models, there were only minor differences found between groups in mother's race, mother's relationship with the father, and mother's education.

Statistical analyses

All data were analyzed using Stata version 13.1 (College Station, TX).Multiple linear regression models were used to determine associations between various forms of screen time and weekday sleep duration. We estimated 2 separate sets of nested regression models. The first set of models assessed data reported by the child at age 9 years (models 1 and 2),whereas the second set of models assessed data reported by the PCG (models 3 and 4).We chose to keep these analyses separate due to variations in how the questions were worded and, thus, coded. Furthermore, we wanted to compare the associations between child-reported screen time and sleep and PCG-reported screen time and sleep. Within each set of models, we created 2 models; we first estimated a regression with only the sleep and screen time variables and then a regression that adjusted for a range of potentially confounding covariates. For both sets of models, we maintained the same covariates in the full model. After estimating all regression models, we performed *F* tests on the final coefficients to compare variances. We also tested for interactions between screen time and both age and race/ethnicity.

Results

Descriptive statistics

Table 1 provides descriptive statistics of our analytic sample. Of the 4898 participating families at baseline, 3630 participated in the age 9wave, and 3269 provided complete information on all variables of interest in the first model. Among this sample, the average weekday sleep duration for 9-year-olds was approximately 9.0 hours (SD, 1.1). Of the focal children, 31.5% spent more than 2 hours watching television or movies per weekday, and 13.8% reported spending more than 2 hours per weekday playing video games, whereas fewer reported spending more than 2 hours per weekday working or chatting on the computer. Approximately half the sample of children were male (52.2%), and among the mothers, 20.7% were white, 50.5% were black, 25.5% were Hispanic, and 3.4% were of other races or ethnicities. Most of the children in the sample had their parents cohabiting (36.2%), friendly (33.9%), or married (22.8%). Furthermore, the majority of mothers (65.0%) had an education less than or equivalent to a high school diploma. The descriptive statistics for the caregiver-reported screen time models are quite similar but, due to a different sample size, are shown separately, in column 2 of Table 1.

Child-reported screen time

Table 2 shows the results of our nested models on the child-report outcomes. In model 1, we find that more than 2 hours per day of chatting on the computer is associated with approximately 16 minutes less sleep per night ($\beta = -0.27$; $P < .05$) and more than 2 hours per day of television or movies is associated with approximately 11 minutes less sleep per night ($\beta = -0.18$; $P < .001$). We did not find a significant association between playing videogames and working on the computer for more than 2 hours per day and weekday nighttime sleep duration.

In model 2, we adjusted for sex, race/ethnicity, parental relationship, and mother's education, which attenuated the results. We find that more than 2 hours per day of television or movies

is associated with 6 minutes less sleep per night (β=−0.10; $P < .05$). However, we did not find a significant association between chatting on the computer and shorter sleep duration in this model. After adjusting for covariates, there was no significant association found between playing video games or working on the computer and weekday sleep duration.

Race/ethnicity, parental relationship, and mother's education were all significant predictors of weekday reported sleep duration. In particular, children of white mothers were more likely to get more sleep than those of other ethnicities, children whose parents were married slept more than other maternal relationships, and children whose mothers had less than or equal to a high school education slept less than those whose mothers attended college.

Caregiver-reported screen time

Table 3 provides results of the nested models estimating the association between parent-reported screen time and parent-reported child's sleep duration. As shown in model 3, every additional hour of watching television or movies is associated with a decrease of approximately 5minutes in sleep duration (β=−0.09; $P < .001$). In addition, we find that every additional hour of computer use is associated with a decrease of approximately 7 minutes (β = −0.11; $P < .001$) in sleep duration. When covariates are added to the model (see model 4), every additional hour of television watching on a weekday is associated with 3 fewer minutes of sleep (β = −0.05; $P < .001$). The exact same magnitude of association was observed for every additional hour of computer use per day (β= −0.05; $P < .05$), which is equivalent to 3 fewer minutes of sleep per hour of computer use.

Among the covariates, those which significantly predicted weekday sleep duration were the same as those in model 2 (mother's race/ethnicity, parental relationship, and mother's education). In particular, children of white mothers, those married to the child's father, and those whose mother's had more education slept more.

Interaction effects

For both child-reported and caregiver-reported screen times, we also tested for interaction effects to see if the association between screen time and sleep duration varies by sex.

There was no significant interaction term by sex at the $P < .05$ level, although when the analyses were stratified by sex, some slight differences emerged. For example, among girls, the associations with sleep duration were only observed for those reporting 2 or more hours of chat time, and, among boys, the associations with sleep duration were only observed with 2 or more hours of television time (results not shown).

When we added an interaction term between screen time and race/ethnicity, we found a significant interaction with video game screen time and sleep, such that whites who played 2 or more hours of video games per day had significantly longer sleep durations than those who did not play video games. Among blacks and Hispanics, the coefficient associated with 2 or more hours of video games was not statistically significant. No interaction effect of race/ethnicity was observed for television or computer use and sleep duration.

When we estimated similar interaction terms with the caregiver-reported screen times, we found no interactions by either age or race/ethnicity.

Discussion

Our findings have shown significant associations between weekday nighttime sleep duration and the use of various screen types by 9-year-olds. Specifically, we found the most substantial reduction in sleep duration when participants reported using the computer, both in the child-reported (chatting) and the caregiver-reported (all computer use) models. However, within each model, an *F* test revealed that the coefficients for the screen time variables were not significantly different from each other. Therefore, we cannot make a conclusion in support of our hypothesis that certain types of screen time are more negatively associated with sleep duration than others or that more interactive screen types have a stronger association with reduced sleep duration than passive screen types. Furthermore, the effect sizes of our results suggested less sleep loss than previously examined in sleep restriction studies performed on children. In a study by Sadeh et al,[35] sleep was restricted by 1 hour for 3 nights, whereas Fallone et al[36] restricted sleep to 4 hours per night. Although the amount of sleep loss observed in the present study was not at the same level, our results still indicate a potentially detrimental degree of sleep loss. Furthermore, our results indicate that greater use of all types of media is associated with shorter sleep duration, regardless of the level interactivity involved in using the screen type. Finally, the evidence is suggestive that these patterns might vary by race/ethnicity or sex.

Several mechanisms have been hypothesized through which media use disrupts sleep.[17,18] First, devoting hours in the day to screen time may decrease the amount of time available for sleep. Second, some media content may cause physiological arousal and impede sleep.[37] Third, it has been shown in young adults that bright light from screens may suppress melatonin, delay sleep onset, and interfere with sleep cycles.[38]

Our results that both computer use and television watching are associated with shorter nighttime sleep duration are in agreement with multiple previous studies. For example, Garmy et al[23] also found that spending more than 2 hours per day watching television or using the computer was associated with shorter sleep duration among school-aged children. Furthermore, BaHammam et al[39] found that children who watched television or played computer games after 8 PM had significantly shorter sleep durations (16 and 15 minutes less, respectively).

Although we did not report a significant finding between video gaming and sleep duration, the inverse association between video gaming and sleep duration has been previously identified. Oka et al[27] found that among Japanese school children, use of the Internet and video games had a larger negative association with sleep/wake parameters (bedtime, wake time, and sleep duration) than watching television. Excessive television watching and video gaming have also been shown by Tazawa and Okada[40] to be associated with physical signs of sleep deprivation among 6- to 11-year-olds. However, Adam et al[41] found that playing video games was not associated with shorter overall sleep duration. These differences may be due to factors such as changes in screen type preferences across age group hypothesized

in the study of Drescher et al,[25] which also reported no association before 13.3 years of age, but did find an association among children older than 13.3 years. Furthermore, the association between time video gaming and nighttime sleep duration has been shown to be greater on weekends than on weekdays among children.[27,41]

Our study provides several strengths and advances the literature on screen time and sleep. First, the FFCW Study allowed us to analyze a demographic that is often understudied in survey-based data. The nationwide data collection amply represented families with lower socioeconomic status, single parents, and racial minorities. Because low socioeconomic status and minority children are often put at a higher risk for insufficient sleep duration due to a wide range of factors,[42] it is important to analyze data where they are well represented. Another strength of the present study is our use of 2 separate measures of screen time: child reported and parent reported. Because both measures had significant associations between reported screen time and sleep duration on the same sample, the results provided each other with a source of validation of the association.

The study has 4 limitations. First, we only had self-reported data available on both screen time and sleep. This presents concerns about the validity and reliability of the data. For example, 1 study found that among school-aged children, a comparison of child actigraphy data with parental report describes dissonant results on sleep duration.[43] In addition, the parent-reported data may not be as accurate among parents who are not as observant of their child's sleep habits. This could be affected by various factors, including the number of children in the household and whether the parent and child share a bedroom. A second limitation is that this study analyzed cross-sectional data at one point in time rather than looking at repeated measures of screen time across multiple nights. As a result, we cannot infer strong conclusions about the causal associations between these 2 factors. Eggermont and Van den Bulck[44] have also noted the possible bidirectionality of the association between sleep duration and technology. Third, because the participants of this study were 9-years-old between 2007 and 2009, the generalizability of their technology use to the present day is somewhat limited. With the rapid growth and change in the technology industry, it is difficult to know how this translates to today's 9-year-olds. Lastly, when testing for interaction effects, the sample sizes of the subgroups were quite small. For example, when we stratified for sex, only 46 girls and 37 boys reported 2 or more hours of chat time. Furthermore, the sample size for non-Hispanic white children who played 2 or more hours of video games per day (n=24 girls and 48 boys) was limited. Therefore, we are careful not to overinterpret the differences found by sex, and we are cautious about interpreting the unexpected direction of the interaction term for race/ethnicity. That said, larger prospective studies may be able to better address these possible interactions.

Future studies should further explore the associations examined in our research. Specifically, we want to know more about multitasking or simultaneous use of screens among school-aged children,[45] as well as how it might affect their sleep. Furthermore, information on presleep habits such as nighttime/bedtime screen use could provide a more meaningful measure to examine, as compared to general daytime screen use.[46] In addition, a follow-up study may investigate whether parenting style modifies the association between screen time and sleep duration,[47,48] as well as the effects of screen time on other behavioral or health

outcomes related to sleep.[49–51] Lastly, future research should include newer forms of technology and media, including smartphones, tablets, and other portable devices.

Although future research could provide a better understanding of the association between sleep and screen exposure, the current evidence has strong implications for both parents and children. With inadequate sleep duration becoming a growing issue across the United States, it is imperative that parents are conscious of how their child's daytime activities may be linked to sleep habits.

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Table 1

Descriptive statistics.

	Child-reported models (n = 3269)	Caregiver-reported models (n = 2770)
	Mean (SD)	**Mean (SD)**
Weekday sleep duration (h)	8.95 (1.11)	9.00 (1.08)
Television use per weekday (h)		2.22 (1.62)
Computer use per weekday (h)		0.81 (0.90)
	Percentage	Percentage
Television use per weekday (h)		
>2 h watching television	31.54	
<2 h watching television	68.46	
Computer use per weekday (h)		
>2 h work on computer	3.3	
<2 h work on computer	96.7	
>2 h chatting	2.54	
<2 h chatting	97.46	
>2 h gaming	13.77	
<2 h gaming	86.23	
Child's sex		
Male	52.22	53.03
Female	47.78	46.97
Mother's race/ethnicity		
White, non-Hispanic	20.71	24.87
Black, non-Hispanic	50.47	47.18
Hispanic	25.45	23.83
Other race/ethnicity	3.36	4.12
Mother's relationship with father		
Married	22.76	28.74
Cohabiting	36.16	34.48
Friendly	33.92	30.54
Hardly or never talk	7.16	6.25
Mother's educational level		
≤ High school diploma	65.00	57.87
Some college or technical college	24.93	28.34
College graduate	10.06	13.79

Table 2

Coefficients of ordinary least squares regression of weekday nighttime sleep duration and child-reported screen time.

	Model 1	Model 2
	Weekday sleep duration (h)	**Weekday sleep duration (h)**
Screen time (ref: <2 h)		
>2 h work on computer per day	−0.16	−0.05
>2 h chatting per day	−0.27*	−0.24
>2 h gaming per day	−0.01	0.02
>2 h watching television per day	−0.18***	−0.10*
Child's sex (ref: female)		
Male	–	−0.01
Mother's race/ethnicity (ref: white)		
Black, non-Hispanic	–	−0.47***
Hispanic	–	−0.13*
Other race/ethnicity	–	−0.36**
Mother's relationship with father (ref: married)		
Cohabiting	–	−0.17**
Friendly	–	−0.16**
Hardly or never talk	–	−0.30***
Mother's educational level (ref: college graduate)		
≤ High school diploma/GED	–	−0.24**
Some college or technical college	–	−0.09
Constant	9.02***	9.60***
Observations	3269	3269
R^2	0.01	0.07

*$P < .05$.

**$P < .01$.

***$P < .001$.

Table 3

Coefficients of OLS regression of weekday nighttime sleep duration and caregiver-reported screen time.

	Model 3	Model 4
	Weekday sleep duration (h)	**Weekday sleep duration (h)**
Screen time (h)		
Duration of television per weekday	−0.09***	−0.05***
Duration of computer use per weekday	−0.11***	−0.05*
Child's sex (ref: female)		
Male	–	−0.04
Mother's race/ethnicity (ref: white)		
Black, non-Hispanic	–	−0.44***
Hispanic	–	−0.12*
Other race/ethnicity	–	−0.38***
Mother's relationship with father (ref: married)		
Cohabiting	–	−0.16**
Friendly	–	−0.15*
Hardly or never talk	–	−0.23*
Mother's educational level (ref: college graduate)		
≤ High school diploma/GED	–	−0.25***
Some college or technical college	–	−0.11
Constant	9.29***	9.73***
Observations	2770	2770
R^2	0.03	0.09

*$P < .05$.

**$P < .01$.

***$P < .001$.