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Associations between screen time and sleep duration are primarily driven by portable electronic devices: evidence from a population-based study of U.S. children ages 0–17

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ABSTRACT

Study objectives: Excessive screen time in child and adolescent populations is associated with short sleep duration, but the unique effects of portable vs. non-portable electronic devices has received little attention. Moreover, it is unknown whether the effects of these devices change across childhood. To address these gaps, the current study compared the association of portable vs. non-portable electronic devices with sleep duration throughout childhood.

Methods: Data were from a 2016 national survey of the caregivers of 43,755 children and adolescents ages 0–17 administered by the U.S. Census Bureau.

Results: Children and adolescents who spent more time on screens slept fewer hours and were more likely to get insufficient sleep. In multivariate regressions including time spent on TV and video game consoles and portable electronic devices, associations with sleep duration were primarily due to portable electronic devices. These results remained when demographic variables, diagnoses of anxiety or depression, physical activity, and BMI were included in the model. Moreover, time spent using both portable and non-portable devices was important for sleep duration in children under age 10, but the importance of non-portable devices diminished in children over 10.

Conclusions: Spending multiple hours a day on electronic devices is associated with shorter sleep duration across all ages. However, portable electronic devices have a stronger association with sleep duration than non-portable electronic screens, with non-portable devices less relevant for sleep duration in children over age 10. The findings suggest that future interventions should uniquely target portable electronic devices while also accounting for the age group of children targeted.

Excessive screen time in child and adolescent populations is associated with short sleep duration [1]. Because spending too much time on electronic devices can have adverse consequences for important developmental processes such as sleep, the American Academy of Pediatrics [2], Canadian Paediatric Society [3], and the Australian Department of Health [4] all recommend that screen time should be limited to less than 2 h in children and adolescents. However, despite such international consensus on limiting screen time, many children and adolescents across the globe exceed these recommendations [5–8]. Even more concerning are reports of increases in screen time over recent years with the rising popularity of portable electronic devices such as cell phones and tablets [9,10].

Although children's use of various electronic devices (eg, watching television, playing video games, using a cell phone) has been linked to insufficient sleep duration [1,11,12], the impact of portable vs. non-portable electronic devices on sleep duration has received little attention. So far, one study suggests that the mere presence of portable devices in the bedroom may be more detrimental than non-portable devices, although this study did not compare the effects of time spent using these devices [13]. To this end, the current study utilized data from a large 2016 national sample of infants, children, and adolescents (ages 0–17) in the United States to evaluate the association between using portable vs. non-portable electronic devices with sleep duration across childhood and adolescence.

Such a focused test is necessary because of the near ubiquity of portable electronic devices, but also because such devices may

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more powerfully undermine sleep duration. For instance, portable devices can be brought directly into the bed and used before sleep as well as during time allocated for sleep. Moreover, it is necessary to consider the relative importance of portable and non-portable electronic devices for different developmental periods during childhood, rather than assuming different types of electronics are equally important for all ages. For example, portable devices may yield stronger associations with sleep duration for teenagers than young children because young children may not own or use portable devices (particularly cell phones) as frequently. Identifying whether portable or non-portable devices play a larger role in predicting insufficient sleep and identifying for what ages these different types of electronics may exert the strongest influence can aid the development of more nuanced and effective recommendations and interventions.

1. Do portable electronic devices have a greater impact on sleep?

There are three key reasons why portable devices specifically could have a stronger effect on sleep duration than non-portable devices. First, portable electronic devices can more directly displace and delay sleep because a child can bring these devices into the bedroom and the bed itself, use them right before bedtime, and when the child is supposed to be sleeping. The ease with which children can use these devices at bedtime is particularly problematic because evening screen time can exert a stronger influence on sleep than screen time during the day [14,15]. Second, children can more easily use portable devices in private spaces (such as the bedroom) without parental monitoring, allowing for easier access to media that might be highly arousing and censored by parents (eg, violent or sexual media). For instance, children with a TV in the bedroom tend to watch more violent or mature content than those without a TV in the bedroom, with such content associated with greater sleep disturbances [14,16]. This pattern of associations likely extends to portable electronic devices given they can easily be taken into the bedroom. Moreover, the privacy afforded by the portable nature of the devices can circumvent parental monitoring, which is itself a protective factor against insufficient sleep duration among adolescents [17]. Third, given their smaller screens, portable devices are held closer to the face than non-portable devices. This is critical because the bright blue light from electronic screens can suppress melatonin onset (a core physiological factor in sleep onset) and the intensity of light emitted decays with the square of the distance from its source [18–20]. Thus, because portable devices are held closer to the face than non-portable devices, they are more likely to emit light sufficiently intense to suppress melatonin release and thereby delay sleep onset and reduce sleep duration (though some portable devices now offer options to change light intensity and wave of light). Although portable devices are expected to exert a more dominant influence on sleep duration than are non-portable devices, their relative importance is likely to vary as a function of age.

2. Electronic device use across childhood

It should come as little surprise that the landscape of electronic device use changes across the spectrum of childhood. As children grow older they become more likely to have electronic devices (and more of them) in the bedroom, use cell phones, watch TV in bed, and spend less time playing video games [5,21,22]. The changes in what devices older children use may also co-occur with changes in what these devices are used for. For instance, the proportion of children electronically communicating with others after bedtime exponentially grows throughout the pre-teen and teenage years [21]. While younger children may be not be as exposed to electronic devices overall or use them in the same way as older children, exposure to any given type of electronic screen may be especially detrimental to sleep in younger children. In particular, light emitted from electronic screens inhibits melatonin release more in children than in adolescents and adults [23,24]. Overall, it is unclear whether portable electronic devices may play a more prominent role in older or younger children and no prior study has examined the relative importance of different types of electronic devices for sleep duration across all ages of childhood.

3. Study purpose

Overall, evidence suggests that portable electronic devices may be a specific risk factor for insufficient sleep duration, and that this effect may change with age. For instance, the association of portable electronic devices with sleep duration may be more pronounced as children grow older and more universally adopt them. To examine these possibilities, this study analyzed survey data collected in 2016 on a national sample of 43,755 children in the United States ages 0–17. In this survey, parents reported on both the child's screen time and sleep duration. Additionally, this survey assessed depression, anxiety, physical activity, body mass index (BMI), as well as a host of demographic variables, all of which are probable confounds in the relation between electronic device use and sleep duration. For instance, overweight children tend to spend more time using electronic screens and are more likely to have short sleep durations [25,26]. Similarly, depressed or anxious individuals are more likely to exhibit problematic cellphone use as well as have more sleep issues [27,28]. Altogether, this large national sample with a comprehensive age range allowed for a highly-powered and precise analysis of how portable vs. non-portable electronic devices associate with sleep duration across the entire spectrum of childhood, while also controlling for important health confounds.

4. Method

4.1. Participants

Participants were the caregivers of 49,700 children 0–17 years of age in the U.S. in the National Survey of Children's Health (NSCH) conducted in 2016 by the U.S. Census Bureau.

Households were contacted by mail at random to identify those with children 17 years old or younger. In every household, one child was randomly selected to be the subject of the survey. The questions were administered via online and paper surveys. The response rate was 40.7%. Data are publicly available on the National Survey of Children's Health website. We excluded children with at least one of eight major conditions that might significantly disrupt their day-to-day functioning and sleep: Autism, blindness, cerebral palsy, deafness, Down Syndrome, developmental delay, epilepsy, or intellectual disability (mental retardation).

In the final sample ($N = 43,755$), the children were 49.8% male and 50.2% female and were 71% White, 16% Hispanic, 6% Black, and 7% other. Family income was widely distributed, with some children below the poverty level and others with family incomes 400% more than the poverty level. The sample was designed to be nationally representative of all U.S. children at these ages but under represents minority groups due to lower response rates.

For some analyses (described below), we grouped children into five categories based on age that roughly correspond to educational levels: Infants and toddlers 0–1 years old, preschoolers 2–5 years old, elementary schoolers 6–10 years old, middle schoolers 11–13 years old, and high schoolers 14–17 years old. These categories correspond to age groups used for sleep duration recommendations and to the questions asked in the survey (see Measures).

4.2. Measures

The survey asked two items about screen time. The first captured time spent on TV and video game consoles: “On an average weekday, about how much time does [child's name] spend in front of a TV watching TV programs, videos, or playing video games?” The second asked about primarily portable electronic devices: “On an average weekday, about how much time does [child's name] spend with computers, cell phones, handheld video games, and other electronic devices, doing things other than schoolwork?” For both, response choices were recoded to none = 0, less than an hour = 0.5, an hour = 1, 2 h = 2, 3 h = 3, and 4 or more hours = 5.

Survey questions on sleep duration differed based on the age of children. Caregivers of children aged five and under were asked, “During the past week, how many hours of sleep did [child's name] get on an average day (count both nighttime sleep and naps)?” with response choices recoded to less than 7 h = 6.5, 7 h = 7, 8 h = 8, 9 h = 9, 10 h = 10, 11 h = 11, and 12 or more hours = 12.5. Caregivers of children aged 6–17 were asked, “During the past week, how many hours of sleep did [child's name] get on an average weeknight?” with response choices recoded to less than 6 h = 5.5, 6 h = 6, 7 h = 7, 8 h = 8, 9 h = 9, 10 h = 10, and 11 or more hours = 11.5.

Caregivers were also asked about diagnoses of anxiety and depression: “Has a doctor or other health care provider ever told you that [child's name] has anxiety problems?” and “Has a doctor or other health care provider ever told you that [child's name] has depression?” For both, response choices were yes or no. Caregivers of children over age six were also asked about the child's physical activity: “During the past week, on how many days did [child's name] exercise, play a sport, or participate in physical activity for at least 60 min?” Response choices were recoded to 0 days = 0; 1–3 days = 2; 4–6 days = 5; every day = 7. For children 10 years of age and older, body-mass index (BMI) was coded as underweight (less than 5th percentile) normal weight (5th to less than 85th), overweight (85th to less than 95th) and obese (95th and greater); to be consistent with other research in the area, BMI was recoded into a dichotomous variable: underweight or normal weight vs. overweight or obese.

4.3. Analysis plan

We first examined sleep duration as a continuous variable (mean hours of sleep) in linear regression equations. In addition, we examined prevalence of insufficient sleep using logistic regression and odds ratios. Based on the recommendations of the National Sleep Foundation, we defined sleep insufficiency as getting 2 or more hours less than the mean hours of sleep recommended: 10 or fewer hours for ages 0–1 (recommended: 12–13 h), 9 or fewer hours for ages 2–5 (recommended: 11), 8 or fewer hours for ages 6–13 (recommended: 10), and 7 or fewer hours for ages 14–17 (recommended: 9).

Analyses included controls for possible confounding variables: child race (dummy variables for Black, Hispanic, and Other, with non-Hispanic White as the comparison group), child sex, child age, household adults' highest grade completed (continuous, using the detailed item including college education), family poverty ratio (a measure of family income), and family structure (living with two biological/adoptive parents vs. not).

Finally, we included anxiety and depression diagnoses, physical activity, and BMI (overweight status) in the model for children 11 years of age and over (BMI was not asked until age 10, and diagnoses of depression were <2% until age 11).

5. Results

Across all age groups, children and adolescents who spent more time on portable electronic devices slept for fewer hours. Children and adolescents who spent more time on TV and video game consoles also slept for fewer hours, except among older adolescents. The associations remained after demographic controls were applied (see Table 1).

Mean hours of screen time within the different age groups are presented in Table 2 along with correlations between the electronic device types. Use of TV/video games and portable devices were positively correlated with each other. Children and adolescents who spent more time on one type of screen were more likely to spend more time on the other type as well (see Table 2). When the two types of screen time were mutually controlled, correlations between sleep duration and TV and video game console time were reduced or eliminated; however, links with portable electronic device time remained (see Table 1 and Fig. 1). Thus, associations between screen time and reduced sleep duration appeared to be primarily driven by time spent on portable electronic devices, namely devices excluding TVs and video game consoles.

Next, we included diagnoses of anxiety or depression, physical activity, and BMI in the model, as these are factors linked to both greater screen time and insufficient sleep. Critically, the associations between screen time and sleep duration remained after these factors were included in the model.

We next considered associations with sleep insufficiency, comparing those who spent 2 h a day or more to those spending 1 h a day or less on each screen activity (roughly corresponding to above and below mean use, and corresponding to physician group recommendations about limits on screen time). Across all age groups, heavy users of portable devices were more likely to get insufficient sleep (see Table 3). Heavy users of TV and video game consoles were also more likely to not sleep enough, except among older adolescents, with odds ratios among age groups significantly different at $p < 0.05$. When demographic variables and the two types of screen time were mutually controlled, the association between screen time and sleep insufficiency was primarily driven by portable electronic devices. The exception was among children ages 6–10, where the odds ratios for reporting insufficient sleep were more similar for both types of screen time (though the odds ratios were still significantly different from each other, $Z = 2.14$, $p < 0.05$; see Table 3). Again, these associations remained when diagnoses of anxiety or depression, physical activity, and BMI were included in the model.

Next, we compared sleep insufficiency at extremes of use (4+ hours vs. none). Two-to 5-year-olds and 6- to 10-year-olds who spent 4 or more hours a day on portable electronic devices were twice as likely to get insufficient sleep than those who spent no time on portable electronic devices (see Fig. 2). Eleven-to 13-year-old adolescents who spent four or more hours a day (vs. no time) on portable electronic devices were 57% more likely to get insufficient sleep, and 14- to 17-year-old adolescents who spent four or more hours a day (vs. no time) on portable electronic devices were 44% more likely to have insufficient sleep (these are calculations of relative risk). Less than 1% of infants and young toddlers (0–1 year) used portable electronic devices 3 h a day or more, so the large differences for this age group should be interpreted with caution.

For time spent on TV and video game consoles, associations with sleep insufficiency were weaker or reversed among adolescents (11–17 years old) and curvilinear among younger children (see Fig. 3). Among 6- to 10-year-old children, those who spent more

Table 1
Standardized Betas from a linear regression predicting hours of sleep.

	TV and video game consoles, hours a day	Portable electronic devices, hours a day
	β (95% CI)	β (95% CI)
Ages 0–1		
Bivariate	−0.18*** (−0.21, −0.15)	−0.20*** (−0.23, −0.17)
Demographic controls	−0.13*** (−0.16, −0.10)	−0.19*** (−0.22, −0.16)
Demographic controls and other screen time	−0.07*** (−0.10, −0.04)	−0.16*** (−0.19, −0.13)
Ages 2–5		
Bivariate	−0.17*** (−0.19, −0.15)	−0.24*** (−0.26, −0.22)
Demographic controls	−0.10*** (−0.12, −0.08)	−0.14*** (−0.16, −0.12)
Demographic controls and other screen time	−0.06*** (−0.04, −0.08)	−0.12*** (−0.14, −0.10)
Ages 0–5		
Bivariate	−0.27*** (−0.29, −0.26)	−0.32*** (−0.34, −0.31)
Demographic controls	−0.10*** (−0.12, −0.08)	−0.15*** (−0.17, −0.13)
Demographic controls and other screen time	−0.05*** (−0.12, −0.08)	−0.12*** (−0.14, −0.10)
Ages 6–10		
Bivariate	−0.21*** (−0.23, −0.19)	−0.23*** (−0.25, −0.21)
Demographic controls	−0.15*** (−0.17, −0.13)	−0.17*** (−0.19, −0.15)
Demographic controls and other screen time	−0.08*** (−0.10, −0.06)	−0.12*** (−0.14, −0.09)
Ages 11–13		
Bivariate	−0.11*** (−0.13, −0.09)	−0.17*** (−0.19, −0.15)
Demographic controls	−0.07*** (−0.09, −0.05)	−0.13*** (−0.15, −0.11)
Demographic controls and other screen time	−0.01 (−0.03, 0.01)	−0.13*** (−0.15, −0.11)
Demographic controls, other screen time, and anxiety, depression, BMI, and physical activity	0.00 (−0.02, 0.02)	−0.12*** (−0.14, −0.10)
Ages 14–17		
Bivariate	0.01 (−0.01, 0.03)	−0.07*** (−0.09, −0.05)
Demographic controls	0.01 (−0.01, 0.03)	−0.05*** (−0.07, −0.03)
Demographic controls and other screen time	0.04*** (0.02, 0.06)	−0.07*** (−0.09, −0.05)
Demographic controls, other screen time, and anxiety, depression, BMI, and physical activity	0.05*** (0.03, 0.07)	−0.06*** (−0.08, −0.04)
Ages 6–17		
Bivariate	−0.13*** (−0.14, −0.12)	−0.30*** (−0.29, −0.31)
Demographic controls	−0.05*** (−0.06, −0.04)	−0.10*** (−0.11, −0.09)
Demographic controls and other screen time	0.00 (−0.01, 0.01)	−0.10*** (−0.11, −0.09)

NOTES: Demographic controls are sex, age, race (black, Hispanic, other), family poverty level, highest educational attainment of an adult in the household, family has two parents or not. For TV and video game consoles, "other screen time" is time on portable electronic devices. For portable electronic devices, "other screen time" is time on TV and video game consoles. ***$p < 0.001$. Sleep duration is measured differently for children 0–5 vs. 6–17, so data cannot be combined across all ages.

Table 2
Mean hours of screen time per day and correlations between the two types of screen time, by and across age groups.

Age group (*n*)	TV and video game consoles mean hrs/day (SD)	Portable electronic devices mean hrs/day (SD)	Correlation between two types of screen time (95% CI)
0–1 (3818)	0.65 (0.94)	0.17 (0.48)	0.37*** (0.34, 0.40)
2–5 (9291)	1.46 (1.09)	0.82 (0.96)	0.41*** (0.39, 0.43)
6–10 (10,561)	1.53 (1.10)	1.25 (1.11)	0.57*** (0.56, 0.58)
11–13 (7490)	1.80 (1.27)	2.00 (1.40)	0.55*** (0.54, 0.57)
14–17 (12,595)	1.89 (1.39)	2.70 (1.53)	0.46*** (0.45, 0.47)
All ages (43,755)	1.59 (1.25)	1.61 (1.49)	0.52*** (0.51, 0.53)

***$p < 0.001$.

than 4 h a day (vs. no time) watching TV or playing video games were 52% more likely to not sleep enough; those who spent 3 h a day were nearly twice likely not to sleep enough. Among 0- to 5-year-olds, sleep insufficiency peaked at 2 h a day of use and then declined slightly.

6. Discussion

Children and adolescents who spent more time on screens slept fewer hours and were more likely to get insufficient sleep, as found in previous research. However, these associations were primarily due to time spent on portable electronic devices such as phones, tablets, and handheld video games, rather than stationary devices such as TVs or video game consoles. Previous research has established that one reason electronic devices disturb sleep is by emitting blue light which then inhibits the release of melatonin associated with sleep onset. Portable electronic devices may have an especially potent inhibitory effect on melatonin because they are held closer to the face, amplifying the intensity of light emitted [18–20]. Moreover, portable devices can be readily brought into the bedroom and bed where they can be used during bedtime and "lights-out" time, a period when melatonin secretion is especially important for sleep onset. The ease with which devices can be brought into the bedroom is also important because using electronic devices an hour before bed produces similar effect sizes on sleep duration as using electronic devices for multiple hours during the daytime [29]. Precisely assessing the time of day of usage is thus an important goal for future research. While portable electronic devices had a much larger relation with sleep duration, it should also be noted that time spent on TV and video game consoles was also often associated with shorter sleep duration. Although, these latter associations were greatly limited after accounting for time spent on portable electronic devices and were more common among younger age groups.

Examining the unique relations of portable and non-portable electronic devices with sleep duration across the full spectrum of childhood was a key contribution of this study. Until age 10, both non-portable and portable screen use independently predicted decreased sleep duration. However, after age 10 the unique effect of non-portable screen time was diminished or reversed, whereas portable screen time maintained a consistent negative association with sleep duration. This may coincide with the age when children are given their own smartphones, which as of 2016 averaged 10 years of age [30]. Thus, while prior studies have found negative relations between

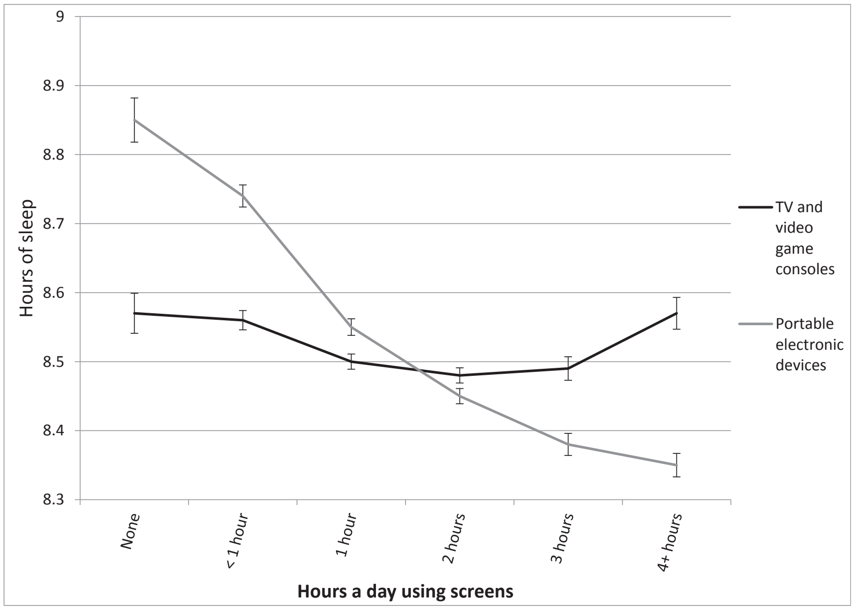

Fig. 1. Mean hours of sleep on weeknights by hours using TV and video game consoles and portable electronic devices, 6- to 17-year-olds. NOTES: Controlled for demographic factors and for the other type of screen time. Error bars are ±1 SE.

Table 3
Sleep insufficiency and screen time: Odds ratios in logistic regression.

	TV and video game consoles 2+ h a day vs. 1 or less	Portable electronic devices 2+ h a day vs. 1 or less
	OR (95% CI)	OR (95% CI)
Ages 0–1		
Bivariate	2.36*** (1.93, 2.90)	6.21*** (4.06, 9.50)
Demographic controls	1.94*** (1.56, 2.42)	5.38*** (3.45, 8.37)
Demographic controls and other screen time	1.61*** (1.27, 2.03)	4.13*** (2.60, 6.58)
Ages 2–5		
Bivariate	1.87*** (1.69, 2.06)	2.65*** (2.36, 2.97)
Demographic controls	1.55*** (1.40, 1.72)	1.93*** (1.70, 2.19)
Demographic controls and other screen time	1.37*** (1.23, 1.53)	1.74*** (1.52, 1.98)
Ages 6–10		
Bivariate	2.26*** (2.07, 2.48)	2.44*** (2.23, 2.68)
Demographic controls	1.85*** (1.68, 2.04)	2.00*** (1.82, 2.19)
Demographic controls and other screen time	1.52*** (1.37, 1.69)	1.69*** (1.51, 1.88)
Ages 11–13		
Bivariate	1.42*** (1.30, 1.56)	1.78*** (1.62, 1.95)
Demographic controls	1.30*** (1.18, 1.43)	1.56*** (1.42, 1.72)
Demographic controls and other screen time	1.11* (1.00, 1.24)	1.51*** (1.36, 1.67)
Demographic controls, other screen time, and anxiety, depression, BMI, and physical activity	1.08 (0.97, 1.21)	1.48*** (1.33, 1.65)
Ages 14–17		
Bivariate	0.97 (0.90, 1.05)	1.42*** (1.29, 1.56)
Demographic controls	0.97 (0.90, 1.00)	1.36*** (1.24, 1.50)
Demographic controls and other type of screen time	0.89** (0.82, 97)	1.41*** (1.28, 1.56)
Demographic controls, other screen time, and anxiety, depression, BMI, and physical activity	0.87** (0.79, 0.94)	1.38*** (1.25, 1.53)

NOTES: Sleep insufficiency is defined as getting 10 or fewer hours for ages 0–1, 9 or fewer hours for ages 2–5, 8 or fewer hours for ages 6–13, and 7 or fewer hours for ages 14–17. Demographic controls are sex, age, race (black, Hispanic, other), family poverty level, highest educational attainment of an adult in the household, and family has two parents or not. For TV and video game consoles, "other screen time" is time on portable electronic devices. For portable electronic devices, "other screen time" is time on TV and video game consoles. * $p < .05$, ** $p < .01$, *** $p < 0.001$. 95% confidence intervals for the odds ratios in parentheses.

non-portable types of electronic devices and short sleep duration in adolescents [17,29] the use of non-portable screens may matter less for short sleep after age 10 once time spent on portable electronic devices is accounted for. This is consistent with findings by Arora and colleagues [31] demonstrating that only cellphone and computer use uniquely predicted sleep duration when time on cellphones, computers, TV, and video games simultaneously predicted sleep duration. The current study also extends these prior findings by demonstrating that both portable and non-portable device time are important for children age 10 and younger. It is also worth noting that across all age groups the association of portable devices with sleep duration almost always had twice the deleterious effect as that of non-portable devices. This held true even for children under two years old, the age group least likely to be exposed to portable electronic devices. Overall, the importance of non-portable electronic devices for sleep duration decreases as children get older, but the importance portable electronic devices was fairly stable across age groups (though smaller for the 14–17 age group).

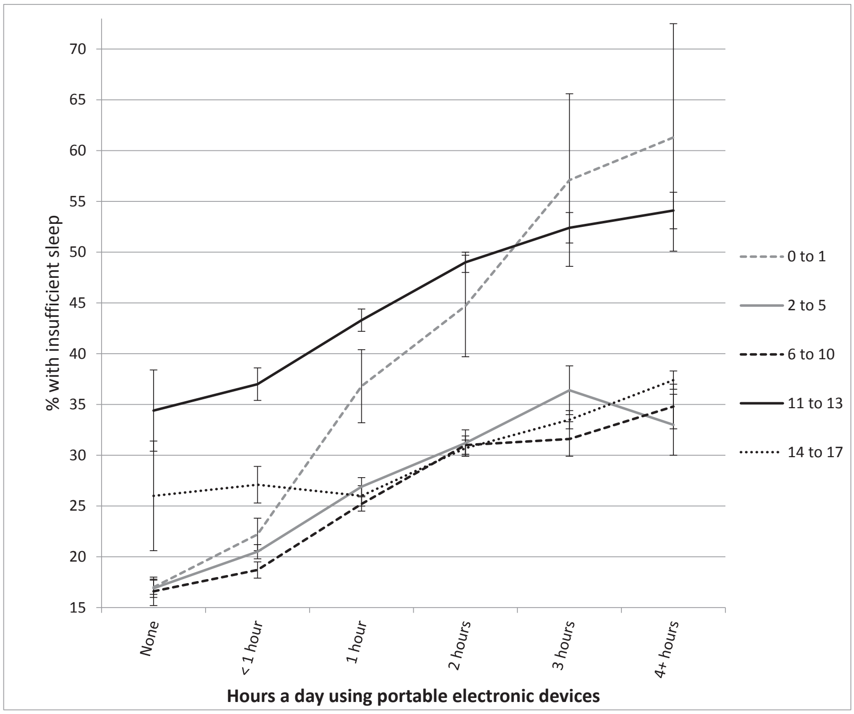

Fig. 2. Percent with insufficient sleep based on hours a day using portable electronic devices. NOTES: Controlled for demographic factors and for TV and video game console time. Error bars are ±1 SE.

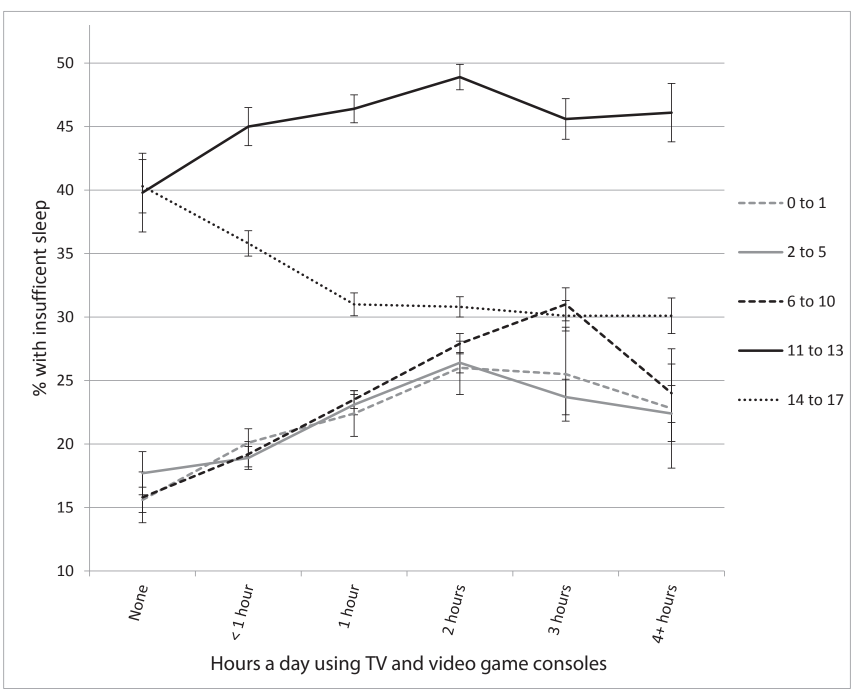

Fig. 3. Percent with insufficient sleep based on hours a day using TV or video game consoles. NOTES: Controlled for demographic factors and for portable electronic device time. Error bars are ±1 SE.

Due to the cross-sectional design of the study, it is not possible to determine if screen time leads to shorter sleep duration, shorter sleep duration leads to screen time, or both. Several longitudinal studies point to a bi-directional relation between shorter sleep duration and greater media use over time [32,33]. In addition to these prospective associations, media use at bedtime has been experimentally manipulated with a disruptive effect on that nights' sleep. For instance, an experimental study utilizing a randomized, crossover design in which participants read from a tablet or a printed book prior to sleep found that the tablet lead to increased nighttime alertness, reduced rapid eye movement sleep, and increased next morning sleepiness [34]. Similarly, preliminary results from a media use reduction intervention in children found increased sleep duration in response to decreased media consumption in the intervention group [35]. Thus, sleep duration seems to respond to changes in electronic device use. Although the current study is cross-sectional, prior longitudinal, experimental, and intervention findings suggest that the observed cross-sectional effects are at least partially capturing the impact of media use on sleep and can lend insights into the differential effects of distinct electronic device use on sleep duration across distinct periods in childhood.

6.1. Limitations and future directions

These data are limited by several factors. First, screen time was reported by caregivers and not the children or adolescents themselves. This likely resulted in underestimates of screen time, particularly for older adolescents, who spend more time unsupervised by parents. In addition, caregivers may overestimate sleep duration, again particularly for older adolescents who generally show a delayed circadian phase [36] and are more likely to be awake later at night when their parents are asleep. Thus, the point estimates may be more accurate for younger children. Second, the survey assessed only weekday screen time, and screen time may be higher on weekends. Yet, previous research found similar associations with well-being for weekday and weekend use of screen media [37]; in addition, weekday screen time is likely less variable and thus less prone to reporting error. Third, the item on portable device use specifically asked about recreational (leisure time) use, excluding schoolwork. Adolescents in particular may use portable devices for schoolwork close to bedtime, which may also interfere with sleep; future research should investigate this question. Fourth, the analyses were limited by the survey questions asked. The question on portable electronic devices included computers, which are not always portable (eg, desktop computers). However, the other devices mentioned in this question (phones, handheld video games) were strictly portable. Regardless, future research should seek to replicate these findings by using questions that specifically assess only portable or non-portable devices. Fifth, although we were able to control for many potential confounds, not all were measured in the dataset. In particular, parenting style may influence both parental monitoring of screen time as well as monitoring of bedtimes. This may be partially accounted for by our controlling for each type of screen time (as parents permissive about one type of screen time are likely permissive about the other type as well); however, parenting style should be explicitly measured in future research. Sixth, although the Census Bureau attempted to recruit a representative sample, the response rate was not 100% and some groups (such as African–Americans) were under-represented relative to their percentage of the total U.S. population in the final sample.

6.2. Policy implications

Previous intervention efforts support electronic device use as a viable intervention point to improve sleep duration [35]. Findings from the current study can be used to further inform how to improve the potency of future interventions with similar goals. Because both non-portable and portable devices were independently associated with sleep duration for children under 10 years old, future interventions designed for children 10 and younger should target both portable and non-portable devices while emphasizing portable devices. However, because non-portable screen time was not negatively associated with sleep duration after age 10, future interventions for pre-teens and adolescents may consider focusing primarily on portable electronic devices.

7. Conclusion

Across all ages, spending multiple hours a day on a variety of electronic devices is associated with reduced sleep duration. However, prior research has not compared the effect of portable vs. non-portable electronic devices, nor examined this effect across the full spectrum of childhood. Current findings indicate that portable electronic devices had a stronger independent connection with sleep duration than did non-portable electronic screens. Moreover, this effect was consistent across all ages and after accounting for important confounds. Altogether, these findings suggest that the ever-increasing ubiquity of portable electronic devices may have harmful effects for sleep in children and suggest that future interventions should uniquely target these devices while also considering developmental stage.

Conflict of interest

None declared.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2018.11.009.

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