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Bedtime screen use behaviors and sleep outcomes: Findings from the Adolescent Brain Cognitive Development (ABCD) Study

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Abstract

Objectives: To determine associations between bedtime screen time behaviors and sleep outcomes in a national study of early adolescents.

Methods: We analyzed cross-sectional data from 10,280 early adolescents aged 10–14 (48.8% female) in the Adolescent Brain Cognitive Development Study (Year 2, 2018–2020). Regression analyses examined the association between self-reported bedtime screen use and self- and caregiver-reported sleep measures, including sleep disturbance symptoms, controlling for sex, race/ethnicity, household income, parent education, depression, data collection period (pre- vs. during COVID-19 pandemic), and study site.

Results: Overall, 16% of adolescents had at least some trouble falling or staying asleep in the past 2 weeks and 28% had overall sleep disturbance, based on caregiver reports. Adolescents who had a television or an Internet-connected electronic device in the bedroom had a greater risk of having trouble falling or staying asleep (adjusted risk ratio 1.27, 95% CI 1.12–1.44) and overall sleep disturbance (adjusted risk ratio 1.15, 95% CI 1.06–1.25). Adolescents who left their phone ringer activated overnight had more trouble falling/staying asleep and greater overall sleep disturbance compared to those who turned off their cell phones at bedtime. Streaming movies,

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playing video games, listening to music, talking/texting on the phone, and using social media or chat rooms were all associated with trouble falling/staying asleep and sleep disturbance.

Conclusions: Several bedtime screen use behaviors are associated with sleep disturbances in early adolescents. The study's findings can inform guidance for specific bedtime screen behaviors among early adolescents.

Keywords

Screen time; Mobile phone; Digital technology; Adolescent; Sleep

Introduction

Sufficient and good quality sleep is vital for healthy behavioral, emotional, and cognitive development in adolescents,[1] and the lack of adequate sleep is associated with health problems like weight gain, poor cognitive development, and socioemotional difficulties.[2] There are significant biological changes in sleep behavior across adolescence, with older adolescents having shorter sleep duration and later sleep times than preadolescents.[3] Against these developmental changes, adolescents are also vulnerable to the impact of various social and environmental factors that compete with sleep, including screen time. The normalization and increasing use of electronic devices[4] have been associated with delayed bedtime and decreased total sleep time in children and adolescents,[5] and this is exacerbated by the fact that the vast majority of preadolescents and adolescents have at least one technological device in their bedrooms, such as a mobile phone, video game console, computer, or television.[6] Adolescents use digital technology for various applications, including social media to constantly connect with peers.[6, 7] All of these factors could have negative consequences for the time available for sleep, which could lead to impairment of daytime functioning, health, mood, and cognitive performance.[2, 6]

The current literature examining the relationship between screen time and sleep has found general associations between daily screen time and poor sleep (see Lund et al., 2021[8] for systematic review). However, most of these studies examine general patterns of screen time and do not specifically consider screen use around bedtime. Prior studies examining screen use around bedtime and sleep outcomes in adolescents have primarily been conducted in smaller European samples, with data collected 10 or more years ago.[9, 10] A study of 362 adolescents from northern Switzerland in 2012–2013 found that watching television or videos, calling or texting, and being online at bedtime was correlated with sleep difficulties; however, these findings relied on bivariate correlations, which were not adjusted for potential confounders.[9] This study did not assess for important bedtime screen activities, including using an electronic device to study, listen to music, or read. A study of 738 adolescents from the Midlands region of the U.K. in 2010 found that bedtime television viewing, video gaming, mobile telephones, music, computer or laptop studying, and the Internet was associated with shorter sleep duration[10]; however, this study did not specifically examine sleep disturbances or difficulty falling or staying asleep as outcomes. One U.S.-based study found that screen use (e.g., computers, laptops, cell phones, video games) in the hour before bedtime was associated with difficulties falling asleep and unrefreshing sleep; however, this study included a wide age range (13–64 years) without a specific focus on

adolescents, with data collected in 2011.[11] Given the constantly evolving nature of digital technology devices and use patterns in the past decade, it is important to update these prior findings with a contemporary, diverse, national U.S. sample of early adolescents.

Several theoretical mechanisms could link screen use before bed and poor sleep. Total time spent on screens may displace time for sleep.[9] Screen use before bedtime across a range of activities may increase physiological, emotional, and mental arousal, which can lead to difficulty falling asleep.[12] Therefore, watching activating content on television or the Internet or engaging in stimulating interactions on phones, chat rooms, or social media could delay falling asleep. Screens have also been shown to emit short blue light wavelengths, which suppress melatonin and reduce sleepiness.[13, 14] Sounds, vibrations, and lights from device notifications overnight could disrupt one's ability to fall and stay asleep.[15, 16, 17, 18, 19, 20] In particular, adolescents may be hypervigilant to the sounds of phone notifications and immediately awaken to the sound of their phone, similar to when a parent awakens upon hearing their crying child.[21, 22]

Mental health considerations, such as depressive symptoms, may have complex and potentially bidirectional relationships with screen use and sleep.[23, 24] On the one hand, people with depression may spend more time on screens and have poorer sleep. Conversely, high screen use may lead to greater depressive symptoms and subsequent poorer sleep.[20]

The purpose of this study was to explore specific associations between screen use around bedtime and during the night with sleep outcomes in a demographically diverse and population-based sample of U.S. early adolescents aged 10–14 years old. Our study advances the current literature by 1) considering multiple contemporary bedtime screen measures assessed by the previous studies (TV/movies, video games, music, phone or text, social media, chat rooms, Internet, computer/laptop for studying)[9, 10, 11] as well as reading, 2) expanding to a larger demographically diverse U.S. sample, 3) focusing on an important period of early adolescence when screen exposure increases and sleep is important for development,[2] and 4) updating these findings in a more contemporary context (2018–2020). We hypothesized that more bedtime screen usage would be associated with sleep disturbances, although associations would vary based on specific screen behaviors. Specifically, we hypothesized that having an electronic device in the bedroom, leaving the phone ringer on, and engaging in any screen activity that could increase arousal (eg, television, video games, social media, talking on the phone, chatting) would be associated with trouble falling or staying asleep and sleep disturbance.

Methods

The Adolescent Brain Cognitive Development (ABCD) Study is a longitudinal study that started following a cohort of 11,878 9–10-years-olds from 21 research sites within the U.S. at baseline (2016–2018). The current study reports data from Year 2, when participants were predominantly 11–12 years old (2018–2020). 10,280 individuals had complete data available for inclusion in this analysis. With the aim of creating a sample representative of the diversity in the U.S., the ABCD Study implemented epidemiologically informed strategies via school systems and attention to sociodemographic factors. Additional details

are outlined elsewhere.[25] Centralized institutional review board approval was obtained from the University of California, San Diego. Study site approvals were obtained from their respective institutional review boards. Caregivers of participants provided written informed consent, and each child participant provided written assent. Participants were compensated for completing the annual assessment.

Exposures

Screen usage around bedtime

A 9-item measure was administered to adolescents to assess engagement in screen activities in bed before sleeping, which was adapted from questionnaires from two prior studies examining adolescent technology use at night.[9, 10] Lemola et al. (2014) assessed for media consumption in bed before going to sleep with four items: watching TV or movies; playing video games; talking on the phone or texting; and spending time online on Facebook, in chat rooms, or surfing the Internet (Cronbach's alpha = 0.70).[9] Arora et al. (2014) assessed for using a computer or laptop for studying; mobile telephone for calling or texting; and music.[10] These screen activities were combined, and an additional item on reading was added to create the Screen Use Around Bedtime questionnaire used in the ABCD Study. On a 5-point Likert scale ranging from 1 (never) to 5 (every night), adolescents reported how often (in the past week) they engaged in the following activities while already in bed before going to sleep: watch TV or movies, play video games, listen to music, talk on the phone or text, spend time online on social media, participate in chat rooms, browse the Internet, use a computer/laptop for studying, and reading. Four additional items were asked related to sleep and screen/phone use, which were adapted from questions in a National Sleep Foundation poll.[11] Adolescents were asked whether there was a TV set or an Internet-connected device in their bedroom (yes/no), what they did with their phone when they were ready to go to sleep (eg, turn the phone off, leave the ringer on), how often they had phone calls, text messages, or emails that woke them after trying to go to sleep, and how often they used their phone or another device after waking up during the night. Participants were asked all Screen Usage Around Bedtime questions regardless of their response choices to prior questions.

Overall screen usage

Total recreational screen time was collected as part of the Youth Screen Time Survey, using adolescents' self-reported hours on a typical weekday and weekend. Assessed screen use included multiplayer gaming, single-player gaming, texting, social media, video chatting, browsing the Internet, and watching/streaming movies, videos, or TV.[26] Total typical daily screen use was calculated as the weighted sum of the weekday and weekend average ([weekday average × 5] + [weekend average × 2])/7.

Outcomes

Kiddie Schedule for Affective Disorders and Schizophrenia (KSADS) DSM-5 sleep outcomes—As part of the ABCD Study, adolescents were asked one question about having problems falling or staying asleep in the past 2 weeks when tired and wanting to sleep, which was adapted from the KSADS DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition) survey, a well-known psychiatric diagnostic assessment

tool for school-aged children. They answered using a 5-point Likert-type scale with answers ranging from 0 (not at all) to 4 (nearly every day).[27] Responses were binarized into 2 categories (those having a problem at least several days in the past 2 weeks vs. those having a problem rarely or never).

Sleep disturbance scale for children

Caregivers completed a 26-item measure to assess the presence of sleep disorders in the adolescent, including disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal, sleep-wake transition disorders, disorders of excessive somnolence, and sleep hyperhidrosis, with a time frame of the past 6 months. An overall sleep-wake disturbance score (sum of all items) was calculated and used in this analysis. Higher scores reflect increased clinical severity of sleep disturbance. Caregivers completed each item using a 5-point Likert scale ranging from 1 (never) to 5 (daily). Based on the recommendations of the developers of the survey,[28] a cutoff of 39 was used to indicate the presence of sleep disturbance.

Confounders

Based on caregivers' self-reports, potential sociodemographic confounders for the association between screen time and sleep outcomes were selected based on previous literature and theory.[6, 11, 29, 30] Sex (female, male) and race/ethnicity (categorical variable with the following categories: non-Latino/Hispanic white [1], Latino/Hispanic [2], non-Latino/Hispanic Black [3], non-Latino/Hispanic Asian/Pacific Islander [4], Native American [5], other [6]) were recorded from the baseline demographic survey. Age (years), household income (U.S. dollars, greater than or less than $75,000—the approximate median U.S. household income), and highest parent education (high school or less vs. college or more) were collected at the Year 2 survey. The study site was also included. The KSADS DSM-5 measure assessing the adolescent for depressed mood (feeling sad, down, or depressed, with the down feeling lasting most of the day in the past 2 weeks) was included as a confounder.[27] Given that the COVID-19 pandemic occurred during the data collection period (November 2018-November 2020), we created a binary pandemic variable (pre- vs. during the pandemic), defining March 13, 2020, as the onset of the COVID-19 pandemic in the U.S.

Statistical analyses

Data analysis was performed in 2022 using Stata 15.1 (StataCorp, College Station, TX). Modified Poisson regression analyses using robust standard errors were conducted to calculate risk ratios estimating associations between screen time before bed and during the night (exposure variable) and sleep problems or disturbance (outcome variables), adjusting for confounders (itemized in the section above). The exposures were considered continuous variables, while the outcomes were binarized into experiencing or not experiencing each specific outcome. We selected a modified Poisson regression approach using robust standard errors for the main analysis, which has shown to be a reliable approach to estimating relative risk compared to logistic regression.[31] In a sensitivity analysis, we tested for effect modification of the "What do you usually do with your phone when you are ready to go to sleep?" question by total recreational screen time on sleep outcomes, but did not find

a significant interaction. Propensity weights were applied to yield representative estimates based on the American Community Survey from the U.S. census. Given potential variation in the association between screen use and sleep by sex based on previous literature,[32] we tested for effect modification by sex on screen use around bedtime. Statistical significance was evaluated after implementing the Benjamini-Hochberg Procedure to address a false discovery rate of 0.05.[33]

Results

In a sample of 10,280 early adolescents (48.8% female, 47.6% racial/ethnic minority), 15.5% reported at least several days of trouble falling/staying asleep in the past 2 weeks, and based on caregiver report, 28.0% had disturbed sleep (scored>39, Table 1). Table 2 shows frequencies and descriptive statistics of bedtime screen behaviors in early adolescents. The majority (63.2%) of early adolescents had a TV or electronic device in their bedroom; most (54.9%) turned their phones off overnight. In the past week, 16.9% reported being woken up by phone calls, text messages, or emails while sleeping at least once. Furthermore, 20.0% reported using their phone or another device if they woke up overnight.

Table 3 shows associations between electronic device usage and sleep outcomes. Having a TV or electronic device in the bedroom was positively associated with self-reported trouble falling or staying asleep (adjusted risk ratio [ARR] 1.27, 95% CI 1.12–1.44) and caregiver-reported overall sleep disturbance (ARR 1.15, 95% CI 1.06–1.25). Leaving the ringer on, compared to turning the phone off, was also positively associated with a higher risk of self-reported trouble falling or staying asleep (ARR 1.23, 95% CI 1.03–1.46) and caregiver-reported overall sleep disturbance (ARR 1.16, 95% CI 1.03–1.30).

Engaging in activities involving various electronic devices before going to sleep was associated with a risk of trouble falling or staying asleep in the past 2 weeks. ARRs ranged from 1.08 (95% CI 1.01–1.15) for using a computer or laptop to study to 1.27 (95% CI 1.17–1.39) for spending time in chat rooms while already in bed before going to sleep. Results were similar for caregiver-reported overall sleep disturbance with an ARR of 1.06 (95% CI 1.01–1.13) for spending time online on social media and 1.10 (95% CI 1.05–1.15) for playing video games while already in bed before going to sleep. Results for all activities are provided in Table 3. Although higher total daily recreational screen time was also associated with trouble falling or staying asleep (ARR 1.04, 95% CI 1.03–1.05) and overall sleep disturbance (ARR 1.02, 95% CI 1.01–1.03), the ARRs were weaker in magnitude than for bedtime-specific screen activities.

Being woken up by phone calls, text messages, or emails after trying to go to sleep on one or more nights in the past week was associated with a higher relative risk of trouble falling or staying asleep in the past 2 weeks (ARR 1.28, 95% CI 1.19–1.39). Using an electronic device after being woken up was associated with significant risks of trouble falling or staying asleep (ARR 1.34, 95% CI 1.25–1.43), and overall sleep disturbance (ARR 1.11, 95% CI 1.06–1.17). There was no evidence of significant effect modification by sex on screen use around bedtime (*P* > .05).

Discussion

In this demographically diverse sample of U.S. 10- to 14-year-old early adolescents, consistent with our hypotheses, we found that screen usage for a range of activities around bedtime (eg, television, video games, social media, talking on the phone, and chatting) was associated with self-reported trouble falling or staying asleep and overall caregiver-reported sleep disturbance in both male and female adolescents. Adolescents who had a television set or Internet-connected electronic device in the bedroom had a higher risk of more trouble sleeping overall compared to their peers who did not have the devices in the bedroom. Compared to turning off cell phones, adolescents who left the ringer activated reported more trouble falling asleep or staying asleep in the past 2 weeks, which may be a simple behavioral modification for some adolescents to prevent sleep disturbance.

Our findings show that bedtime screen activities such as watching television and videos, playing video games, texting, chatting, and engaging in social media were associated with trouble falling or staying asleep, as well as overall sleep disturbances, which are in accordance with prior studies conducted on technology and sleep.[11] Screen use around bedtime may be linked to sleep disturbances through multiple mechanisms. Although speculative since our study did not directly measure blue light, many screen devices (eg, computers, tablets, readers, and cell phones) emit blue light (400–495 nm), which suppresses melatonin secretion, a hormone that promotes a state of drowsiness.[34, 35] Suppression of melatonin may induce phase-shifting in the circadian clock, leading to delayed sleep onset latency and sleep disturbances.[35] Other potential mechanisms include increased alertness and cognitive arousal related to content or activity on devices, vibrational disturbances from devices, notification sound and light from devices, and decreased association with the bedroom as a sleep environment.[15, 16, 17, 18, 19, 20]

We did not find an association between reading (using an electronic device) before going to sleep and sleep problems. Reading has been shown to be associated with longer sleep duration and shorter time to fall asleep in a Chinese study surveying community members above the age of 40, but the mechanism remains dubious.[36, 37] Reading can decrease long-cognitive arousal, reduce stress on similar levels to doing yoga or watching comedy videos,[38] and is associated with a lower risk of insomnia.[38] On the other hand, reading could increase immediate arousal levels due to the requisite comprehension elements such as perspective taking, story mapping, and other anatomical activations that occur in the brain.[39] Interventional studies are needed to determine if reading—including on an electronic device —is beneficial for sleep.

In addition to pre-sleep bedtime screen activities, not turning the ringer off and being woken up by electronic devices were associated with sleep problems, which is consistent with previous literature. Adolescents may especially be sensitive to the sounds of phone notifications.[21, 22] A prospective cohort study showed that mobile phone-related nocturnal awakenings increased the odds of developing problems with falling asleep by more than 3 times and restless sleep by more than 5 times a year later in adolescents ages 13–15 years.[40] Authors speculate that participants reporting mobile phone-related awakenings might engage more in phone usage before bedtime and that waiting for another message might prevent

them from falling asleep or having a restful sleep.[40] In contrast, it is possible that certain adolescents may experience nomophobia, or the fear of being detached from mobile phone connectivity, and could experience sleep disturbance if their phones were turned off.[41, 42] Examining nomophobia and fear of missing out on communication when disconnected could be a future area of research on screens and sleep. The current analysis also found an association between using an electronic device after waking up during the night and reporting sleep problems. Adolescents who already have trouble sleeping may possibly turn to their electronic devices when they wake up. Future waves of data from the ABCD Study may be useful in determining the directionality of the associations we found here.

Within this study, there are several strengths and limitations worth noting. The large, diverse, and population-based sample is a major strength, which gives the study great external validity. Another strength is the evaluation of specific electronic device-based activities, including browsing the Internet and using social media, and the focus on bedtime and during the night usage in association with sleep outcomes. The limitations of this study include its cross-sectional nature, such that causal relationships may not be inferred, and residual confounders may exist. Individuals' reports of self-screen use are often found to be less accurate compared to objectively measured use.[43] The sample is also vulnerable to recall bias due to sleep and screen usage behaviors being asked about retrospectively. Some items were self-reported by adolescents (bedtime screen use, difficulty falling/staying asleep), while the Sleep Disturbance Scale was caregiver reported. Caregivers may overestimate the adolescent's sleep; therefore, associations we found between screen usage and self-reported sleep problems may be more reflective of the true relationships. The bedtime screen use questionnaire did not specify the content or context of the screen use (eg, the type of video game, social media, reading, and whether they were interacting with others), which could affect the extent of sleep disturbances. Others have highlighted the importance of contextual factors when considering the effects of screen use on sleep in children.[30] For instance, being a "gamer" and the family context of screen use could be included as covariates in future research. Some effect sizes were small, particularly for the caregiver reports of sleep disturbance.

This study advances our understanding of screen usage behaviors and associated sleep outcomes among early adolescents and suggests that limiting screen usage around bedtime may help these populations with sleep management. Health care providers could educate parents and adolescents on specific screen behaviors around bedtime. Family media use plans informed by The American Academy of Pediatrics may help facilitate conversations about household screen rules, such as limiting screen use in the hour before bedtime. Greater knowledge of screen use behaviors can inform and strengthen future early adolescent-focused interventions across numerous technological platforms. Future studies could incorporate objective screen use and sleep measures to better understand the complex mechanisms linking screen usage behaviors around bedtime, sleep, and mental health.

Acknowledgments

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Table 1.

Sociodemographic characteristics, recreational screen time use, and sleep problems for participants in the Adolescent Brain Cognitive Development (ABCD) Study (N = 10,280)

Sociodemographic characteristics	Mean (SD)[a]/%
Age (y), year 2	12.02 (0.66)
Sex (%), baseline	
Female	48.8%
Male	51.2%
Race/ethnicity (%), baseline	
White, non-Latino/Hispanic	52.4%
Latino/Hispanic	20.1%
Black, non-Latino/Hispanic	17.3%
Asian, non-Latino/Hispanic	5.5%
Native American	3.2%
Other	1.5%
Household income (%), Year 2	
Less than $75,000	47.6%
$75,000 and greater	52.4%
Parents' highest education (%), Year 2	
High school education or less	20.3%
College education or more	79.7%
Data collection period	
Pre-COVID-19 pandemic[b]	73.3%
During COVID-19 pandemic	26.7%
Depressed mood (%), Year 2	2.3%
Screen time[c]	
Total recreational screen time (hours per day), year 2	7.19 (5.82)
Trouble falling/staying asleep (%), year 2[d]	
No	84.5%
Yes	15.5%
Overall sleep disturbance (%), year 2[e]	
No	72.0%
Yes	28.0%

ABCD propensity weights were applied based on the American Community Survey from the U.S. Census.

[a]SD, standard deviation.

[b]Pre-COVID-19 pandemic defined as before March 13, 2020.

[c]Weighted sum for weekdays and weekends.

[d]Adolescent-reported sleep problems at least several times in the past 2 weeks.

[e]Caregiver-reported score of>39 on the Sleep Disturbance Scale.

Table 2.

Bedtime electronic device usage in the Adolescent Brain Cognitive Development (ABCD) Study (N = 10,280, Year 2)

Is there a TV set or an Internet-connected electronic device (computer, iPad, phone) in your bedroom?	Yes	No		
	63.2%	36.8%		

What do you usually do with your phone when you are ready to go to sleep?	Turn the phone off	Put the ringer on silent or vibrate	Leave the ringer on	Put it outside of the room where I sleep
	54.9%	18.3%	11.8%	14.9%

How many nights in the past week did you engage in the following activities involving electronic devices while already in bed before going to sleep?	0 nights	1–2 nights	3–4 nights	5–7 nights
Watch or stream movies, videos, or TV shows	48.4%	27.2%	10.4%	14.0%
Play video games	70.6%	16.6%	6.8%	5.9%
Play music	53.2%	22.4%	10.2%	14.2%
Talk on the phone or text	65.9%	19.6%	7.9%	6.6%
Spend time online on social media (eg, Facebook)	69.4%	16.5%	7.5%	6.6%
Spend time in chat rooms	89.0%	7.3%	2.2%	1.5%
Browse the Internet, Google (not school related)	78.9%	15.9%	3.6%	1.6%
Use a computer/laptop for studying	70.8%	16.7%	7.7%	4.8%
Reading	40.6%	26.7%	15.4%	17.4%
In the past week, how often have you had phone calls, text messages or emails that wake you after trying to go to sleep?	83.1%	11.0%	3.6%	2.3%
In the past week, when you woke up during the night, how often have you used your phone or other device to send messages/play games/search or browse the Internet/use social media/read or write emails?	80.0%	12.4%	4.7%	2.9%

ABCD propensity weights were applied based on the American Community Survey from the U.S. Census.

Table 3.

Associations between bedtime electronic device usage and sleep in the Adolescent Brain Cognitive Development (ABCD) Study (N = 10,280)

	Trouble falling or staying asleep, adolescent report		Overall sleep disturbance, caregiver report	
	ARR	**P**	**ARR**	**P**
Is there a TV set or an Internet-connected electronic device (computer, iPad, phone) in your bedroom?	**1.27 (1.12, 1.44)**	**<.001**	**1.15 (1.06, 1.25)**	**<.001**
What do you usually do with your phone when you are ready to go to sleep?				
Turn the phone off	referent		referent	
Put the ringer on silent or vibrate	1.09 (0.94, 1.26)	.274	1.01 (0.91, 1.12)	.874
Leave the ringer on	**1.23 (1.03, 1.46)**	**.022**	**1.16 (1.03, 1.30)**	**.013**
Put it outside of the room where I sleep	0.98 (0.83, 1.15)	.781	0.89 (0.80, 1.01)	.064
How many nights in the past week did you engage in the following activities involving electronic devices while already in bed before going to sleep?				
Watch or stream movies, videos, or TV shows	**1.15 (1.09, 1.21)**	**<.001**	**1.07 (1.03, 1.11)**	**<.001**
Play video games	**1.22 (1.14, 1.29)**	**<.001**	**1.10 (1.05, 1.15)**	**<.001**
Play music	**1.20 (1.14, 1.25)**	**<.001**	**1.09 (1.05, 1.13)**	**<.001**
Talk on the phone or text	**1.16 (1.09, 1.23)**	**<.001**	**1.09 (1.04, 1.13)**	**<.001**
Spend time online on social media (eg, Facebook)	**1.16 (1.10, 1.23)**	**<.001**	**1.06 (1.01, 1.11)**	**.009**
Spend time in chat rooms	**1.27 (1.17, 1.39)**	**<.001**	**1.08 (1.01, 1.15)**	**.029**
Browse the Internet, Google (not school related)	**1.19 (1.10, 1.29)**	**<.001**	1.06 (1.00, 1.13)	.053
Use a computer/laptop for studying	**1.08 (1.01, 1.15)**	**.021**	1.00 (0.95, 1.05)	.880
Reading	1.05 (1.00, 1.10)	.058	1.02 (0.99, 1.06)	.165
How often have you had phone calls, text messages or emails that wake you after trying to go to sleep?	**1.28 (1.19, 1.39)**	**<.001**	1.06 (1.00, 1.12)	.072
When you woke up during the night, how often have you used your phone or other device to send messages/play games/search or browse the Internet/use social media/read or write emails?	**1.34 (1.25, 1.43)**	**<.001**	**1.11 (1.06, 1.17)**	**<.001**
Total Recreational Screen Time	**1.04 (1.03, 1.05)**	**<.001**	**1.02 (1.01, 1.03)**	**<.001**

ARR, adjusted risk ratio. Adjusted models represent the abbreviated output from Poisson regression models transformed to risk ratios, including covariate adjustment for sex, race/ethnicity, household income, parent education, study site, data collection period (pre- vs. during COVID-19 pandemic), and depression. Propensity weights from the ABCD Study were applied based on the American Community Survey from the U.S. Census. Bold indicates statistical significance after implementing the Benjamini-Hochberg procedure.