Child and Adolescent Mental Health

Child and Adolescent Mental Health Volume **, No. *, 2023, pp. **–** doi:10.1111/camh.12665

The role of sleep in prospective associations between parent reported youth screen media activity and behavioral health

Darlynn M. Rojo-Wissar[1,2,3], Juliana Acosta[4], Karissa DiMarzio[5], Megan Hare[5], Chelsea F. Dale[5], Wesley Sanders[6,7] & Justin M. Parent[1,2,3]

[1]*Department of Psychiatry and Human Behavior, Warren Alpert Medical School of Brown University, Providence, RI, USA*
[2]*Bradley/Hasbro Children's Research Center, E.P. Bradley Hospital, Providence, RI, USA*
[3]*E.P. Bradley Hospital Sleep Research Laboratory, Providence, RI, USA*
[4]*Mailman Center for Child Development, University of Miami Miller School of Medicine, Miami, FL, USA*
[5]*Florida International University, Miami, FL, USA*
[6]*Home Base, a Red Sox Foundation and Massachusetts General Hospital Program, Charlestown, MA, USA*
[7]*Harvard Medical School, Boston, MA, USA*

Background: Screen media activity (SMA) can negatively affect youth behavioral health. Sleep may mediate this association but has not been previously explored. We examined whether sleep mediated the association between SMA and youth behavioral health among a community sample. **Method:** Parents completed questions about their child (N = 564) ages 3–17 at Wave 1, Wave 2 (4–8 months later), and Wave 3 (12 months later). Path analyses were conducted to examine links between Wave 1 SMA and Wave 3 behavioral health problems (i.e., internalizing, externalizing, attention, peer problems) through Wave 2 sleep disturbance and duration. **Results:** SMA was significantly associated with greater sleep disturbance, β = .11, 95% CI [.01, .21] and shorter sleep duration, β = −.16 [−.25, −.06], and greater sleep disturbance was associated with worse youth behavioral health across internalizing, β = .14 [.04, .24], externalizing, B = .23 [.12, .33], attention, β = .24 [.15, .34], and peer problems, β = .25 [.15, .35]. Longer sleep duration was associated with more externalizing, β = .13 [.04, .21], and attention problems, β = .12 [.02, .22], and fewer peer problems, β = −.09 [−.17, −.01], but not with internalizing problems. Lastly, there was a direct effect of SMA on peer problems, β = −.15 [−.23, −.06] such that higher SMA that does not impact sleep may have a positive impact on reducing peer problems. **Conclusions:** Sleep (i.e., disturbances and shorter duration) may partially account for the small associations observed between SMA and worse behavioral health in youth. To continue expanding our understanding, future research should utilize more diverse representative samples, use objective measures of SMA and sleep, and examine other relevant aspects of SMA, including content, device type, and timing of use.

Key Practitioner Message

- Previous studies have pointed to a negative association between SMA and behavioral health; yet, mechanisms underlying this association have not been elucidated.
- Utilizing a prospective design, we show that the SMA is associated with worse sleep (i.e., disturbance and shorter duration), which is in turn associated with worse youth behavioral health.
- SMA may only negatively affect youth behavioral health if it negatively affects sleep (i.e., disturbances and shorter duration).
- When SMA does not negatively affect youth sleep, it may have positive effects on youth peer functioning.
- Interventions targeting sleep health among youth may help mitigate the detrimental effects of SMA on behavioral health.

Keywords: technology; externalizing; internalizing; attention; peers

Introduction

The longer time spent engaged in screen media activity (SMA) has been linked to negative physical and behavioral health outcomes in youth (Costigan, Barnett, Plotnikoff, & Lubans, 2013; Li et al., 2019; Lissak, 2018; Page, Cooper, Griew, & Jago, 2010; Riehm et al., 2019). Yet, the mechanisms by which SMA leads to such disturbances (e.g., trouble falling asleep, nighttime awakenings, insufficient sleep, daytime sleepiness) have not been elucidated. One mechanism that warrants further consideration in explaining this association is youth sleep. With greater time spent engaged in SMA, there is less time available for sleep, and SMA is associated with shorter sleep duration among youth (Hale & Guan, 2015). SMA may also affect sleep duration and quality through increases in psychological and physiological arousal related to media content and social interaction, and through suppression of the sleep-timing hormone melatonin, via blue light exposure (Chang, Aeschbach, Duffy, & Czeisler, 2015; Hale & Guan, 2015). Because poor-sleep quality and short-sleep duration are linked to a myriad of negative health outcomes (Alvaro, Roberts, & Harris, 2013; Owens et al., 2014), poor sleep may, in part, account for the negative effects of SMA on behavioral health.

One major shortcoming of previous research examining associations among SMA, sleep, and youth behavioral health outcomes is the use of cross-sectional data (Guerrero, Barnes, Chaput, & Tremblay, 2019; Leung & Torres, 2021; Li et al., 2019; Vandendriessche et al., 2019). Additionally, previous research examining longitudinal associations between SMA and sleep have primarily focused on sleep duration and not disturbances (e.g., difficulty initiating or maintaining sleep) (Belmon, van Stralen, Busch, Hamsen, & Chinapaw, 2019). Lastly, there is a lack of prospective investigations examining whether there are differential effects of developmental stage on the association between SMA, sleep, and behavioral health outcomes among youth. The developmental stage is an important consideration, as the duration recommendations for sleep (Hirshkowitz et al., 2015) and SMA (Guram & Heinz, 2018) differ by age, suggesting there may be sensitive developmental periods for the influence of SMA and sleep on youth health.

To address these limitations in the current study, we prospectively examined whether sleep disturbances and duration mediated the association between SMA and youth behavioral health (i.e., internalizing, externalizing, attention, peer problems) in a community sample of families in the United States. We also extend previous research by examining the nature and magnitude of these relationships across developmental stage (i.e., early childhood, middle childhood, adolescence) to explicate potential differences. We hypothesized that youth SMA at baseline would be associated with 12-month behavioral health problems through sleep across all developmental stages.

Methods

Participants and procedure

Data from 564 parents of children between the ages of 3 and 17 were included in the current study. OSF page for all de-identified data, code, and output can be found at https://osf.io/3ka2r/ (DOI: 10.17605/OSF.IO/3KA2R). Participants were predominately White (79.0%), with an additional 9.8% who identified as Black, 5.7% as Latinx, 4.5% as Asian, and 1.0% as American Indian, Alaska Native, or other Pacific Islander. Parents' education level ranged from not completing high school or the H.S. equivalent (0.4%), obtaining an H.S. degree or GED (12.8%), attending some college (30.5%), earning a college degree (40.6%), and attending at least some graduate school (15.9%). Most parents were employed full-time (61.7%) with 19.5% reporting employment at a part-time level, and 18.8% reporting unemployment. Reported family income was 21.7% for less than $30,000 per year, 28.7% between $30,000 and $50,000, 19.5% between $50,000 and $70,000, 16.8% between $70,000 and $100,000, and 13.3% at least $100,000. Parent marital status was organized into three categories with 17.1% reporting being single, 64.6% being married, and 18.3% being in a cohabiting relationship. Approximately half of the youth were boys (54.4%) with 38.5% being an only child.

With approval from the University of Vermont's institutional review board (CHRBSS: 14-551), parents of 3- to 17-year-old youth were recruited via Amazon's Mechanical Turk (MTurk) as part of a larger study on parenting, from 2014 to 2015. The study was listed separately for three age groups (early childhood [ages 3–7], middle childhood [ages 8–12], and adolescence [ages 13–17]). Parents were asked to fill out questions about their child at baseline (Wave 1), 4 and 8 months later (averaged for Wave 2), and 12 months later (Wave 3). Participants (n = 2) were not included in the study (i.e., their data were removed from the dataset) if they had more than one incorrect response to attention check items (e.g., Please select the Almost Never response option). Further, participants were also excluded if their demographic data was not consistently entered across waves. We allowed for one-time potential mistakes, such as inconsistent gender or entering the date-of-birth wrong at a single time point but excluded participants who made such mistakes at more than one wave (n = 51). These participants were removed prior to analyses and are not included in the N and reported demographics above. MTurk is currently the most widely used internet-based crowdsourcing application in the social sciences (Chandler, Mueller, & Paolacci, 2014) and has been suggested to be reliable and valid in child and family research (Parent, Forehand, Pomerantz, Peisch, & Seehuus, 2017). Parents consented online prior to beginning the survey and were compensated for completion of the survey at each wave. Participation requirements included US resident status and having a minimum task approval rate on MTurk of 95%. Retention rates for parents for at least one wave after Wave 1 was 74.6% and 66.1% at the 12-month follow-up (Wave 3).

Measures

Youth weekly screen media activity. Parents were asked two questions regarding their youth's SMA: "Now thinking about [youth]'s typical activities, on a typical *weekday* ("*weekend*" in second question) how much time does [youth] spend doing each of the following at home?" Parents responded with the number of hours and/or minutes their child engaged in each of the following activities: (a) watching TV or DVDs; (b) using a computer; (c) playing video games on a console gaming system (such as Xbox, PlayStation, and Wii); (d) playing on a handheld gaming system, such as a Gameboy, PSP, or DS; (e) using a tablet (such as an iPad); and (f) using a smartphone for activities such as playing games, watching videos or browsing the Internet (not including time spent talking on the phone). Weekday and weekend SMA was highly correlated, $r = .839$, $p < .001$. Thus, a daily average SMA variable (averaged across weekend and weekday use) was calculated by device and then summed across all devices used. The method used in this study to measure child SMA was similar to those used by major industry reports and other peer-reviewed research (Gingold, Simon, & Schoendorf, 2014; Parent, Sanders, & Forehand, 2016; Sanders, Parent, Forehand, & Breslend, 2016).

Sleep disturbance and duration. An abbreviated version of the Children's Sleep Habits Questionnaire (CSHQ) (Owens, Spirito, & McGuinn, 2000) was used to measure youth sleep disturbance and duration. The CSHQ is a widely used parent-report questionnaire to assess for youth sleep problems and has been shown to be highly correlated with objective measures of sleep, such as actigraphy. Parents rated the frequency of their youth's sleep behavior over the most recent "typical" week on a 4-point Likert scale (*usually* as 5–7 times/week; *sometimes* as 2–4 times/week; *rarely* as 0–1 time/week; and *never* as less than once/week), with higher scores indicating more sleep disturbances. Seven items were chosen to measure sleep disturbance: frequency of child having a consistent bedtime, sleep onset latency within 20 min, consistent sleep duration, restless sleep, night wakings, tired during the day, and falling asleep during daily activities. Higher scores represented more sleep disturbance.

To assess sleep duration, parents reported what time their youth typically goes to sleep on weeknights and weekend nights separately, and what time they typically wake up on weekdays and weekend days. Average daily sleep duration was calculated from these by multiplying the weekday totals by 5 (days), adding it to the weekend totals multiplied by 2, and dividing the total by 7. Abbreviated versions of the CSHQ have shown adequate psychometric properties, including high correlations with the full version, sensitivity to change, and discriminating between children with vs without a parent-reported behavioral sleep problem (e.g., Bonuck, Goodlin-Jones, Schechter, & Owens, 2017; Reed et al., 2009). The reliability of the current version across waves was acceptable (Ω = .64–.73).

Youth internalizing, externalizing and attention behavioral health problems. The parent form of the 19-item Brief Problem Monitor (BPM) (Achenbach, McConaughy, Ivanova, & Rescorla, 2011) assesses three indices of youth behavioral health problems: internalizing, externalizing, and attention problems. Each item is rated on a 0 to 2 scale (0 = *not true*, 1 = *somewhat true*, 2 = *very true*), with higher scores indicating more internalizing (reliability Ω across waves = .80–.84), externalizing (Ω = .84–.85), or attention problems (Ω = .83–.84). The BPM was originally developed for 6–18-year-olds, with items selected from the Child Behavior Checklist (CBCL) and Youth Self-Report (YSR) (Achenbach & Rescorla, 2001) measures using factor analysis and item response theory (Chorpita et al., 2010). The BPM was shown to have excellent internal consistency, test–retest reliability and validity (Achenbach et al., 2011; Chorpita et al., 2010), with a later study expanding the age range for acceptable use of the BPM for measuring internalizing symptoms to children 3–17 years (Ebesutani, Tottenham, & Chorpita, 2015). Though measurement of externalizing symptoms from the BPM has not been validated in preschoolers explicitly, the items were developed by applying item response theory and factor analysis to the Youth Self-Report (YSR; Achenbach & Rescorla, 2001) and Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) measures, with all externalizing and most internalizing symptom items in the BPM matching those from the validated school-aged and preschool versions (Achenbach & Rescorla, 2000) of the CBCL.

Peer problems. Peer problems were assessed with the peer problem subscale of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997). Responses to the five questions (e.g., tends to play alone) were answered on a 3-point Likert scale (0 = *not true*, 1 = *somewhat true*, or 2 = *certainly true*), with higher scores indicating more peer problems (Ω = .68–.71). Psychometric properties of this measure are well established, demonstrating good internal consistency (Björnsdotter, Enebrink, & Ghaderi, 2013; Bourdon, Goodman, Rae, Simpson, & Koretz, 2005; Goodman, Ford, Simmons, Gatward, & Meltzer, 2000).

Covariates. Parents reported youth race, ethnicity, sex, BMI, family income, parent marital status, and parental education. Socioeconomic status (SES) indicators were dichotomized to create a summary SES variable indicating a count of the number of adverse SES factors (range 0–3). Family income was coded as 0 for those above the United States national poverty level, and 1 for those below the United States national poverty level. For marital status, those in two parent households were coded as 0, and those in a single parent household were coded as 1. Lastly, those with parental educational attainment of a college degree were coded as 0, and those with and parental educational attainment less than a college degree were coded as 1. We used a single count variable of the number of adverse SES indicators so that we could control for the effects of cumulative adverse SES factors without decreasing power in our models. We also ran the models with each SES indicator variable (i.e., poverty, parental education, single-parent status) entered into the model as separate observed binary variables as a sensitivity analysis. For analyses, we created a binary race/ethnicity variable due to most participants identifying as non-Hispanic White. Covariates were selected for inclusion based on previous research on SMA, sleep, and youth behavioral health (Barlett, Gentile, Barlett, Eisenmann, & Walsh, 2012; Guerrero et al., 2019; Keyes & Kreski, 2020; Leung & Torres, 2021).

Data analytic plan

Prior to primary data analyses, lowess plots of associations between sleep duration and youth behavioral health variables were visually inspected for the possibility of u-shaped associations, so that, if present, we could account for such associations in our models. Path analyses were conducted using Mplus version 8.3 (Muthén & Muthén, 2017) to test the hypothesized longitudinal model examining the link between youth SMA and behavioral health problems through sleep disturbances and duration. The following fit statistics were used to evaluate model fit: Chi-square (χ^2 > .05 excellent), comparative fit index (CFI; >.90 acceptable, >.95 excellent), root mean square error of approximation (RMSEA; <.08 acceptable; <.05 excellent), and the standard root mean square residual (SRMR; <.08 acceptable, <.05 excellent). Full information maximum likelihood estimation techniques were used for inclusion of all available data. The Model Indirect command in Mplus was utilized to calculate a standardized indirect effect parameter and biased-corrected bootstrap confidence intervals. The multiple-group function in Mplus was used to determine whether direct associations differed by developmental stage via model fit and Wald chi-square test of parameter equalities. Indirect effects in models freely estimated across groups were considered to be significantly different by developmental stage if there was no overlap in the 95% CIs. Models were adjusted for the following baseline variables: youth gender, race, number of adverse SES factors, BMI, and sleep duration, sleep disturbance, and behavioral health variables (i.e., internalizing problems, externalizing problems, attention problems, peer problems).

Results

There was no evidence of a u-shaped relationship between sleep duration or any of the youth behavioral health variables. Youth characteristics included in analyses are presented in Table 1 among youth of all ages, and by developmental stage. The youth were 54% male, 79% Non-Hispanic White, and 38% had no adverse SES factors.

Primary analyses among youth of all ages

The model demonstrated excellent fit χ^2 (58, N = 561) = 147.23, p < .001, RMSEA = .05, 90% confidence interval (CI), .042–.063, CFI = .93, SRMR = .06. Standardized estimates of stability paths of behavioral health and sleep and covariances are reported in Table S1. Baseline behavioral health variables were associated with 12-month behavioral health variables, and baseline sleep variables were associated with 6-month sleep variables. Standardized estimates of the direct effects of SMA on sleep, sleep on behavioral health, and SMA on behavioral health are reported in Figure 1. Youth SMA at Wave 1 was associated with greater sleep disturbances and shorter sleep duration at Wave 2. Greater sleep disturbances at Wave 2 were associated with more internalizing, externalizing, attention, and peer problems at Wave 3. Longer sleep duration at the Wave 2 was associated with more externalizing and attention problems, and fewer peer problems, but not with internalizing problems at Wave 3. There were no direct effects of Wave 1 SMA on Wave 3 internalizing, externalizing, or attention problems (p's > .05). However, higher levels of baseline SMA was associated with lower levels of 12-month peer problems. The only indirect effect was of baseline

Table 1. Youth characteristics overall and by developmental stage

	Total *N* = 564	Early childhood *N* = 192	Middle childhood *N* = 177	Adolescence *N* = 195	*p*-Value
Baseline characteristics					
Gender, *n* (%)					
Female	257 (45.6)	83 (43.2)	84 (47.5)	90 (46.2)	.70
Male	307 (54.4)	109 (56.8)	93 (52.5)	105 (53.8)	
Race\Ethnicity, *n* (%)					
Other	118 (20.9%)	40 (20.8%)	37 (20.9%)	41 (21.0%)	1.00
Non-Hispanic White	443 (78.5%)	151 (78.6%)	140 (79.1%)	152 (77.9%)	
Missing	3 (0.5%)	1 (0.5%)	0 (0.0%)	2 (1.0%)	
Number of SES factors, *n* (%)					
0	212 (37.6)	70 (36.5)	71 (40.1)	71 (36.4)	.60
1	184 (32.6)	66 (34.4)	53 (29.9)	65 (33.3)	
2	142 (25.2)	48 (25.0)	48 (27.1)	46 (23.6)	
3	26 (4.6)	8 (4.2)	5 (2.8)	13 (6.7)	
BMI, mean ± *SD*	24.27 ± 7.44	**23.24 ± 8.51**	**22.71 ± 6.47**	**26.65 ± 6.56**	**<.001**
Internalizing Problems, mean ± *SD*	1.46 ± 2.00	**1.03 ± 1.62**	**1.45 ± 1.90**	**1.90 ± 2.31**	**<.001**
Externalizing Problems, mean ± *SD*	1.95 ± 2.48	1.97 ± 2.34	2.12 ± 2.89	1.76 ± 2.21	.37
Attention Problems, mean ± *SD*	2.76 ± 2.78	2.77 ± 2.59	2.97 ± 3.04	2.56 ± 2.71	.37
Peer Problems, mean ± *SD*	1.80 ± 1.95	1.81 ± 1.88	1.61 ± 2.03	1.98 ± 1.95	.19
Screen Media Activity (hr), mean ± *SD*	5.44 ± 3.00	**4.17 ± 2.54**	**4.93 ± 2.68**	**7.27 ± 2.87**	**<.001**
Sleep Duration (hr), mean ± *SD*	9.24 ± 1.62	**10.35 ± 1.78**	**9.10 ± 1.23**	**8.31 ± 1.05**	**<.001**
Sleep Disturbances, mean ± *SD*	11.83 ± 3.03	**11.70 ± 3.02**	**11.45 ± 2.97**	**12.31 ± 3.06**	**.02**
6-month follow-up					
Sleep duration (hr), mean ± *SD*	9.35 ± 1.34	**10.35 ± 1.27**	**9.32 ± 0.99**	**8.44 ± 1.02**	**<.001**
Sleep Disturbances, mean ± *SD*	11.80 ± 2.78	11.50 ± 2.53	12.01 ± 3.08	11.87 ± 2.66	.33
12-month follow-up					
Internalizing Problems, mean ± *SD*	1.66 ± 2.22	1.39 ± 1.83	1.77 ± 2.40	1.81 ± 2.36	.29
Externalizing Problems, mean ± *SD*	1.83 ± 2.54	2.14 ± 2.45	1.84 ± 2.94	1.50 ± 2.14	.16
Attention Problems, mean ± *SD*	2.58 ± 2.77	**3.10 ± 2.86**	**2.67 ± 2.81**	**1.98 ± 2.55**	**.01**
Peer Problems, mean ± *SD*	1.59 ± 1.86	1.34 ± 1.55	1.52 ± 1.95	1.92 ± 2.01	.06

Statistically significantly different group comparisons are bolded.

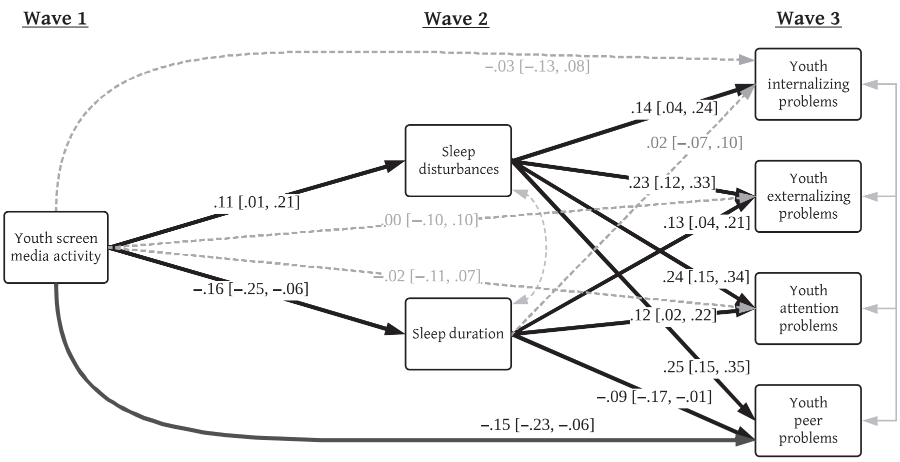

Figure 1. Path diagram of standardized direct effects of associations among screen media activity, sleep, and behavioral health in youth of all ages. Covariates, stability pathways, and covariances are not depicted. Family SES, youth race, gender, BMI, and stability paths (controlling for W1) were included as covariates but are not depicted to simpliy presentation of primary results. Bold lines are statistically significant. Gray dashed lines are $p > .05$. Model fit: χ^2 (58, N = 561) = 147.23, $p < .001$, RMSEA = .05, 90% confidence interval (CI), .042–.063, CFI = .93, SRMR = .06.

SMA on 12-month externalizing problems through 6-month sleep duration (β = −.02, 95% CI = −.04, −.001), though several of the indirect effects had *p*-values between .05 and .10.

Moderation by developmental stage

The only direct effect among SMA, sleep, and behavioral health that was moderated by developmental stage was the path from sleep duration to externalizing problems, Wald χ^2 (2) = 6.66, p = .036. For youth in the early childhood developmental stage, longer sleep duration was associated with more externalizing problems, β = .30, 95% CI = .05, .56, but not for youth whose developmental stage was middle childhood, β = .40, 95% CI = −.01, .80, or adolescence, β = −.13, 95% CI = −.37, .11. 95% CIs for indirect effects of SMA on behavioral health

Table 2. Unstandardized indirect effects by developmental stage

	Early childhood			Middle childhood			Adolescence		
	Estimate	CI lower limit	CI upper limit	Estimate	CI lower limit	CI upper limit	Estimate	CI lower limit	CI upper limit
SMA → Sleep Disturbances → Internalizing Problems	.049	−.011	.396	.005	−.019	.029	.003	−.015	.021
SMA → Sleep Disturbances → Externalizing Problems	**.056**	**.001**	**.111**	.009	−.034	.052	.019	−.016	.055
SMA → Sleep Disturbances → Attention Problems	**.077**	**.015**	**.138**	.007	−.028	.043	.027	−.024	.078
SMA → Sleep Disturbances → Peer Problems	**.062**	**.003**	**.122**	.008	−.03	.047	.025	−.02	.069
SMA → Sleep Duration → Internalizing Problems	−.008	−.027	.011	−.011	−.038	.017	.004	−.014	.022
SMA → Sleep Duration → Externalizing Problems	−.019	−.044	.007	−.026	−.064	.012	.006	−.012	.024
SMA → Sleep Duration → Attention Problems	−.018	−.044	.008	−.002	−.03	.026	.013	−.023	.049
SMA → Sleep Duration → Peer Problems	.008	−.013	.029	−.02	−.054	.015	.002	−.013	.018

Bolded values indicate significant effects.
Family SES, youth race/ethnicity, gender, and BMI were included as covariates. SMA, screen media activity.

through sleep largely overlapped across developmental stages (see Table 2 for unstandardized indirect effects); however, mediation effect sizes were substantially larger for sleep disturbances and externalizing, attention, and peer problems in early childhood and were only associated in this developmental stage.

Sensitivity and supplemental analyses

The tested alternative models to examine the robustness of findings based on (a) the assessment wave used for youth sleep mediators, (b) how SES was modeled, and (c) differential associations between SMA and youth sleep and behavioral health outcomes based on the type of SMA. First, our primary models averaged the 4-month and 8-month sleep assessments to create single W2 variables because of the high correlation and in an effort to have equal time-intervals between each wave in our longitudinal mediation model. We instead explored models using 4-month of 8-month sleep mediators instead of the combined wave. One association in the alternative 4-month model (sleep duration to youth internalizing) and one in the 8-month model (sleep duration to youth attention problems) changed from $p < .05$ to $p < .10$, though the effect sizes were similar across models. Results support the robustness of associations such that the direction and magnitude of effects were comparable regardless of which way sleep was modeled. Second, we used a composite SES variable as a covariate in our primary model that was similar to a count cumulative risk variable. Alternatively, we examined a model with parent single parent status, family poverty level, and parental education as covariates instead of a single SES variable and found no changes in magnitude, direction, or statistical significance of associations in the model.

Finally, we examined models that included time spent on each type of SMA (i.e., TV, computer, console video games, mobile video games, tablet, smartphone) as separate predictors of sleep and youth behavioral health outcomes. We found similar findings. First, direct associations between SMA type and youth outcomes were largely non-significant. The exceptions were a direct association between video game use and externalizing problems, $\beta = -.116$, $p = .018$, and there was a lack of a direct association between SMA type and peer problems. For sleep outcomes, we found a direct association between video game use and both sleep duration, $\beta = -.123$, $p = .002$, and disturbances, $\beta = .105$, $p = .015$. Unexpectedly, we also found a negative association between time spent watching TV and sleep disturbances, $\beta = -.108$, $p = .035$. Overall, SMA continued to impact youth sleep which, in turn, resulted in higher levels of youth behavioral health problems.

Discussion

In the current study, we used data from a community sample to prospectively evaluate whether SMA contributed to behavioral health problems (i.e., internalizing, externalizing, attention, peer problems) in youth ages 3–17, through sleep (i.e., disturbances, duration), and whether these associations differed by developmental stage (i.e., early childhood, middle childhood, adolescence). Longer SMA at Wave 1 was associated with greater sleep disturbances and shorter sleep duration at Wave 2 among youth from each developmental stage. In turn, greater sleep disturbances at Wave 2 were associated with worse youth behavioral health at Wave 3. Longer sleep duration was associated with more externalizing and attention problems, fewer peer problems, and was not significantly associated with internalizing problems. There were no direct effects of SMA on behavioral health. Results were mostly consistent in each developmental stage. Findings suggest that the small negative effects of SMA on behavioral health outcomes among youth may be accounted for by the negative effects of SMA on sleep.

Placing our findings in the context of previous research, the associations that we observed between

SMA and sleep are consistent with a systematic literature review documenting longitudinal associations between SMA and poor sleep in youth (Hale & Guan, 2015; Hisler, Hasler, Franzen, Clark, & Twenge, 2020). For direct effects of sleep on behavioral health, greater sleep disturbances were associated with more internalizing, externalizing, attention, and peer problems among youth, which is consistent with a robust body of literature linking sleep disturbances to youth behavioral health (Gregory & O'Connor, 2002; Gregory & Sadeh, 2012). Our findings that longer sleep duration was linked to more externalizing and attention problems and fewer peer problems but was not associated with internalizing symptoms were somewhat unexpected given previous research (Bélanger, Bernier, Simard, Desrosiers, & Carrier, 2018; Chaput et al., 2016; Pesonen et al., 2010; Scharf, Demmer, Silver, & Stein, 2013; Vriend et al., 2013; Wang et al., 2013; Wu et al., 2017). Of note, these effects were small. Weekend oversleep has been associated with more externalizing (Pasch, Laska, Lytle, & Moe, 2010) and attention problems (Kim et al., 2011), and may account for our findings. Reasons for weekend oversleep involving socializing (e.g., nighttime social interaction with peers during the school week) may also explain why longer sleep was associated with fewer peer problems. Additional research is needed to test these hypotheses.

There are several mechanisms that may account for observed associations between sleep and youth behavioral health outcomes. The Sleep to Internalizing Pathway in Young Adolescents (SIPYA) Model posits that sleep-related problems in adolescence lead to disruption in brain network dynamics and increase risk for internalizing disorders by increasing repetitive negative thought (Akbar, Mattfeld, Laird, & McMakin, 2022). The circadian system has also been implicated. Children whose chronotype is more eveningness oriented are more likely to exhibit externalizing problems, which may partially result from increased susceptibility to daytime impairment in executive functions, affect, and emotional and physiological reactivity related to sleep problems, which are common in this group (Schlarb, Sopp, Ambiel, & Grünwald, 2014). Overall, the relationship between sleep and behavioral health is likely bidirectional, with both genetic and environmental factors interacting to affect both through complex pathways, including through their influence on hormones (e.g., melatonin, cortisol) and neural and psychological processes (For more comprehensive reviews in these areas see Akbar et al., 2022; Bijlenga, Vollebregt, Kooij, & Arns, 2019; Gregory & Sadeh, 2012; Schlarb et al., 2014).

SMA did not have a direct effect on internalizing, externalizing, or attention problems. Though at first glance these findings may seem surprising given previous work demonstrating links between SMA and behavioral health (Costigan et al., 2013; Li et al., 2019; Lissak, 2018; Page et al., 2010; Riehm et al., 2019), there are several potential explanations. First, much of this previous work does not control for baseline behavioral health and is subject to residual confounding (Keyes & Kreski, 2020). Second, there are other components of SMA that were not examined that may have stronger associations with behavioral health, such as media type, number of devices, active versus passive use, use after dark, media content, and how users engage with social media in particular (Clark, Algoe, & Green, 2017; Lissak, 2018; Scott & Woods, 2019; Seabrook, Kern, & Rickard, 2016). Lastly, consequences of SMA, such as sleep loss and disturbance, may be associated with poor behavioral health outcomes to a larger extent than SMA itself (Hökby et al., 2016). SMA did however have a direct effect on peer problems, such that longer SMA at baseline was associated with fewer peer problems at the 12-month follow-up, which is consistent with previous research (Paulich, Ross, Lessem, & Hewitt, 2021). This association may be accounted for by use of social media to foster meaningful social connections, leading to fewer peer problems like isolation (Clark et al., 2017).

Though there was only one indirect effect of SMA on behavioral health through sleep (i.e., the effect of SMA on externalizing symptoms through sleep duration), this is likely due to power limitations, as findings from the path models suggest that SMA does indirectly affect behavioral health through disruptions in youths' sleep health. Lastly, the only relationship among SMA, sleep, and behavioral health that differed by which developmental stage participants were in was the small association of longer sleep duration with more externalizing problems, which was only present in those who were in early childhood. Though there were only indirect effects of SMA on higher levels of youth externalizing, attention, and peer problems through sleep disturbances among those who were in early childhood, with the largest effect sizes in this group, the 95% CIs of these indirect effects overlapped with those in middle childhood and adolescence. This result paired with research showing some youth may be more sensitive than others to the impact of SMA on internalizing and externalizing behaviors (Sanders, Parent, Abaied, et al., 2018) suggest promise for future research exploring for whom and under which circumstances SMA impacts youth health, as it could have important clinical implications. For example, if additional research suggests that early childhood appears to be a time of particular sensitivity to the effect of SMA on sleep health, professionals working with parents of young children might consider providing greater psychoeducation and targeted intervention on how to best manage screen time.

Because SMA appears to mostly affect behavioral health outcomes among youth through sleep, interventions that reduce the negative effects of SMA on sleep may help ameliorate the negative effects of SMA on youth behavioral health. For example, brief single session parenting interventions show promise for reducing youth SMA (Sanders, Parent, Abaied, et al., 2018) and parenting practices, such as warmth, hostility, and emotion socialization are longitudinally associated with youth sleep health (e.g., Acosta et al., 2021). Further, findings from a recent systematic review and meta-analysis suggest that the magnitude of the effects of interventions to control screen use and its effects on sleep are larger when sleep is the primary intervention target (Martin, Bednarz, & Aromataris, 2021). Cognitive behavioral interventions targeting sleep led to a 29-minute increase in daily sleep duration on average, among adolescents (Blake, Sheeber, Youssef, Raniti, & Allen, 2017). Among school-age children and adolescents, cognitive behavioral sleep interventions are also associated with reductions in sleep onset latency (Åslund, Arnberg, Kanstrup, & Lekander, 2018). Interventions aiming to improve sleep related to SMA may also focus on limiting nighttime use (especially before bedtime), use of blue light blockers, and eliminating the presence of electronics in the sleep environment (Chang et al., 2015; Hale & Guan, 2015; Lissak, 2018).

Furthermore, given the well-established literature linking sleep to health outcomes in youth (Chaput et al., 2016; Gregory & O'Connor, 2002; Gregory & Sadeh, 2012), it will be important to identify groups at highest risk for poor sleep as a result of SMA, as individual differences in biopsychosocial characteristics can play a significant role in disease vulnerability and response to treatment. This article is a step in the right direction, indicating the indirect pathway of SMA on behavioral health through sleep disturbances was largely consistent across youth in different developmental stages. Future research should also examine effects longitudinally in the same youths across developmental stages to evaluate whether there are within-person differences by age. Previous research suggests that stress physiology may be another potential moderator (Coyne et al., 2015; Sanders, Parent, Abaied, et al., 2018), and should be examined in future research. Future research should also explore other potential differential susceptibility factors (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011), which will help identify groups most in need of intervention and optimize treatment response in these groups. Our results suggest that limiting the negative effects of SMA on sleep may mitigate the detrimental effects of SMA on behavior health outcomes in youth of all ages. In addition, the null direct findings of SMA on youth health, combined with the positive findings on peer relationships, emphasize the need to further understand how content may play a role in positive outcomes. Taken together, future research may want to focus on quality over quantity when assessing both sleep behavior and SMA, as this may lead to a better understanding of potential negative and positive pathways to development in youth.

Strengths and limitations

While previous literature has largely consisted of cross-sectional data, our prospective study design strengthens our ability to make causal inferences regarding the associations among SMA, sleep, and behavioral health problems among youth. Another major strength of our study that also contributes to our ability to make causal inferences is that we were able to control for major confounders (e.g., BMI, SES) (Keyes & Kreski, 2020). Further, our study's examination of youth in different developmental stages and assessment of multiple dimensions of sleep (i.e., sleep duration *and* quality) are also strengths, as previous studies have largely examined singular aspects of each.

Despite these strengths, our findings should be considered in light of the study's limitations. First, the sample is predominantly non-Hispanic White, which limits the generalizability of our findings. Relatedly, the average ratings for behavioral health problems in this sample were low. While more mild-to-moderate ratings are expected given our use of a community sample, this fact is important to acknowledge given it may account for some of the observed null findings. As such, future research might consider evaluating associations between SMA, sleep health, and behavioral problems using at-risk and clinical samples.

We used an abbreviated form of the CSHQ to minimize participant burden (the short form of the CSHQ [SF–CSHQ; Bonuck et al., 2017] was not yet developed), but still capture a representative range of sleep disturbances from the original CSHQ. Though internal consistency reliability of the measure was acceptable, there are fewer items in our version compared to the later developed SF–CSHQ, which limits comparability across studies. Another limitation is the lack of multiple informants and lack of objective methods for assessing constructs. For example, despite some evidence suggesting similar reliability and validity of parental and youth report compared to objective assessments (e.g., Combs et al., 2019), relying solely on parent report likely did not comprehensively capture all dimensions that encompass sleep (e.g., efficiency, continuity, awakenings), particularly for adolescents whose parents may be less aware about their difficulties initiating and maintaining sleep. Further, we did not have data on habitual sleep onset latency or wake after sleep onset that we could incorporate into our calculation of total sleep time, though calculating total sleep time from parent reported bed and wake times only has been shown to be moderately correlated with actigraphy measured total sleep time (Mazza, Bastuji, & Rey, 2020). For this reason, future research should use multiple informants, multiple methods for assessing sleep (e.g., questionnaire, actigraphy), and passive methods for assessing SMA (e.g., through collecting usage directly from devices). Though limitations exist for objective SMA assessment for youth (e.g., youth sharing devices with siblings or parents), emerging research on passive sensing tools is encouraging (Barr et al., 2020) and may provide further depth to our understanding of potential detrimental effects of SMA. In particular, objective or in-depth multiformat measures of SMA would allow for testing hypotheses regarding specificity of association regarding timing of use (e.g., in the hour before bed; Levenson et al., 2017), the type of activity (e.g., passive vs. active media use; Werneck, Hoare, Stubbs, van Sluijs, & Corder, 2021), and emotional responses to SMA (e.g., negative emotional responses to social media use; Nesi et al., 2022). Lastly, data in the current study were collected in 2014–2015 and may not account for possible changes in patterns of or perspectives on screen time since that time, such as the COVID-19 pandemic (e.g., Nagata et al., 2022).

Clinical implications

From early childhood to adolescence, longer habitual SMA generally exhibits small but significant associations with worse behavioral health through poorer sleep (i.e., sleep disturbances and shorter sleep duration), with sleep disturbances having a stronger effect. Findings suggest a nuanced picture of how SMA can have a negative impact on youth health when it detrimentally impacts sleep; however, when SMA does not result in sleep problems, SMA may also have positive impacts, including on increased social engagement and reduced peer problems. The current results have important clinical implications, particularly given the high prevalence of SMA and poor sleep among children and adolescents (Meltzer & Mindell, 2008; Strasburger et al., 2013). Interventions focusing on reducing the negative effects of SMA on sleep may mitigate the negative effects of SMA on behavioral health among youth. Further, our findings and previous research underscore the benefit of enhancing youth's sleep health, not only to thereby address maladaptive SMA, but also as a mechanism for behavioral health improvement. Whereas specifically targeting SMA may be valuable in reducing unhelpful practices (Sanders, Parent, & Forehand, 2018), clinical efforts may be advantageously streamlined by addressing sleep to ameliorate various aspects of youth's functioning including their sleep, behavioral health, and SMA. Indeed, targeted sleep interventions have commonly addressed unhelpful SMA within their protocols and previously led to meaningful improvements in youth's behavioral health (e.g., Blake et al., 2017; McMakin et al., 2019). In turn, the use of cognitive and behavioral sleep strategies may provide a fruitful opportunity to mitigate the negative effects that stem from SMA, sleep, and behavioral health transactional relations.

Acknowledgements

This research was supported by the Child and Adolescent Psychology Training and Research, Inc (JP), NICHD F31HD082858 (JP), F31HD101257 (JA), T32DA043449 (MH). DMR is supported by the Eunice Kennedy Shriver National Institute of Child Health & Human Development's Training Program in Childhood Stress, Trauma, & Resilience (T32HD101392; PIs: Stroud, Laura & Tyrka, Audrey). The last author is supported by the Bradley Hospital COBRE Center for Sleep and Circadian Rhythms in Child and Adolescent Mental Health (P20GM139743, PI Carskadon) and by the National Institute on Minority Health and Health Disparities (R01MD015401, PI Parent). The funding organizations had no role in the design and conduct of the study, collection, analysis, and interpretation of the data. All authors have indicated they have no financial relationships relevant to this article to disclose. The authors have declared that they have no competing or potential conflicts of interest.

Ethical information

This study was approved by the University of Vermont's institutional review board (CHRBSS: 14-551).

Correspondence

Darlynn M. Rojo-Wissar, Department of Psychiatry and Human Behavior, Initiative on Stress, Trauma, & Resilience (STAR), Center for Behavioral and Preventive Medicine, The Miriam Hospital, Warren Alpert Medical School of Brown University, 1 Hoppin Street, Coro West, Suite 204, Providence, RI 02903, USA; Email: darlynn_rojo-wissar@brown.edu

Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Standardized model results: covariance and stability.

References

Achenbach, T.M., McConaughy, S.H., Ivanova, M.Y., & Rescorla, L.A. (2011). *Manual for the ASEBA brief problem monitor (BPM)* (p. 33). Burlington, VT: ASEBA.

Achenbach, T.M., & Rescorla, L.A. (2000). *Manual for the ASEBA Preschool Forms & Profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Achenbach, T.M., & Rescorla, L.A. (2001). *Manual for the ASEBA school-age forms & profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families.

Acosta, J., Parent, J., DiMarzio, K., McMakin, D.L., McKee, L.G., & Dale, C.F. (2021). Longitudinal associations between parenting practices and youth sleep problems. *Journal of Developmental & Behavioral Pediatrics*, *42*, 751–760.

Akbar, S.A., Mattfeld, A.T., Laird, A.R., & McMakin, D.L. (2022). Sleep to internalizing pathway in Young adolescents (SIPYA): A proposed neurodevelopmental model. *Neuroscience & Biobehavioral Reviews*, *140*, 104780.

Alvaro, P.K., Roberts, R.M., & Harris, J.K. (2013). A systematic review assessing bidirectionality between sleep disturbances, anxiety, and depression. *Sleep*, *36*, 1059–1068.

Åslund, L., Arnberg, F., Kanstrup, M., & Lekander, M. (2018). Cognitive and behavioral interventions to improve sleep in school-age children and adolescents: A systematic review and meta-analysis. *Journal of Clinical Sleep Medicine*, *14*, 1937–1947.

Barlett, N.D., Gentile, D.A., Barlett, C.P., Eisenmann, J.C., & Walsh, D.A. (2012). Sleep as a mediator of screen time effects on US children's health outcomes. *Journal of Children and Media*, *6*, 37–50.

Barr, R., Kirkorian, H., Radesky, J., Coyne, S., Nichols, D., Blanchfield, O., ... & Fitzpatrick, C. (2020). Beyond screen time: A synergistic approach to a more comprehensive assessment of family media exposure during early childhood. *Frontiers in Psychology*, *11*, 1283.

Bélanger, M.È., Bernier, A., Simard, V., Desrosiers, K., & Carrier, J. (2018). Sleeping toward behavioral regulation: Relations between sleep and externalizing symptoms in toddlers and preschoolers. *Journal of Clinical Child and Adolescent Psychology*, *47*, 366–373.

Belmon, L.S., van Stralen, M.M., Busch, V., Hamsen, I.A., & Chinapaw, M.J.M. (2019). What are the determinants of children's sleep behavior? A systematic review of longitudinal studies. *Sleep Medicine Reviews*, *43*, 60–70.

Belsky, J., Bakermans-Kranenburg, M.J., & van IJzendoorn, M.H. (2007). For better and for worse. *Current Directions in Psychological Science*, *16*, 300–304.

Bijlenga, D., Vollebregt, M.A., Kooij, J.J.S., & Arns, M. (2019). The role of the circadian system in the etiology and pathophysiology of ADHD: Time to redefine ADHD? *ADHD Attention Deficit and Hyperactivity Disorders*, *11*, 5–19.

Björnsdotter, A., Enebrink, P., & Ghaderi, A. (2013). Psychometric properties of online administered parental strengths and difficulties questionnaire (SDQ), and normative data based on combined online and paper-and-pencil administration. *Child and Adolescent Psychiatry and Mental Health*, *7*, 1–10.

Blake, M.J., Sheeber, L.B., Youssef, G.J., Raniti, M.B., & Allen, N.B. (2017). Systematic review and meta-analysis of adolescent cognitive–behavioral sleep interventions. *Clinical Child and Family Psychology Review*, *20*, 227–249.

Bonuck, K.A., Goodlin-Jones, B.L., Schechter, C., & Owens, J. (2017). Modified children's sleep habits questionnaire for behavioral sleep problems: A validation study. *Sleep Health*, *3*, 136–141.

Bourdon, K.H., Goodman, R., Rae, D.S., Simpson, G., & Koretz, D.S. (2005). The strengths and difficulties questionnaire: U.S. normative data and psychometric properties. *Journal of the American Academy of Child and Adolescent Psychiatry*, *44*, 557–564.

Chandler, J., Mueller, P., & Paolacci, G. (2014). Nonnaïveté among Amazon Mechanical Turk workers: Consequences and solutions for behavioral researchers. *Behavior Research Methods*, *46*, 112–130.

Chang, A.M., Aeschbach, D., Duffy, J.F., & Czeisler, C.A. (2015). Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness.

Proceedings of the National Academy of Sciences of the United States of America, *112*, 1232–1237.
Chaput, J.P., Gray, C.E., Poitras, V.J., Carson, V., Gruber, R., Olds, T., … & Tremblay, M.S. (2016). Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. *Applied Physiology, Nutrition and Metabolism*, *41*, S266–S282.
Chorpita, B.F., Reise, S., Weisz, J.R., Grubbs, K., Becker, K.D., & Krull, J.L. (2010). Evaluation of the brief problem checklist: Child and caregiver interviews to measure clinical progress. *Journal of Consulting and Clinical Psychology*, *78*, 526–536.
Clark, J.L., Algoe, S.B., & Green, M.C. (2017). Social network sites and well-being: The role of social connection. *Current Directions in Psychological Science*, *27*, 32–37.
Combs, D., Goodwin, J.L., Quan, S.F., Morgan, W.J., Hsu, C.H., Edgin, J.O., & Parthasarathy, S. (2019). Mother knows best? Comparing child report and Parent report of sleep parameters with polysomnography. *Journal of Clinical Sleep Medicine*, *15*, 111.
Costigan, S.A., Barnett, L., Plotnikoff, R.C., & Lubans, D.R. (2013). The health indicators associated with screen-based sedentary behavior among adolescent girls: A systematic review. *Journal of Adolescent Health*, *52*, 382–392.
Coyne, S.M., Dyer, W.J., Densley, R., Money, N.M., Day, R.D., & Harper, J.M. (2015). Physiological indicators of pathologic video game use in adolescence. *Journal of Adolescent Health*, *56*, 307–313.
Ebesutani, C., Tottenham, N., & Chorpita, B. (2015). The revised child anxiety and depression scale - Parent version: Extended applicability and validity for use with younger youth and children with histories of early-life caregiver neglect. *Journal of Psychopathology and Behavioral Assessment*, *37*, 705–718.
Ellis, B.J., Boyce, W.T., Belsky, J., Bakermans-Kranenburg, M.J., & van Ijzendoorn, M.H. (2011). Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory. *Development and Psychopathology*, *23*, 7–28.
Gingold, J.A., Simon, A.E., & Schoendorf, K.C. (2014). Excess screen time in US children: Association with family rules and alternative activities. *Clinical Pediatrics*, *53*, 41–50.
Goodman, R. (1997). The strengths and difficulties questionnaire: A research note. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *38*, 581–586.
Goodman, R., Ford, T., Simmons, H., Gatward, R., & Meltzer, H. (2000). Using the Strengths and Difficulties Questionnaire (SDQ) to screen for child psychiatric disorders in a community sample. *British Journal of Psychiatry*, *177*, 534–539.
Gregory, A.M., & O'Connor, T.G. (2002). Sleep problems in childhood: A longitudinal study of developmental change and association with behavioral problems. *Journal of the American Academy of Child and Adolescent Psychiatry*, *41*, 964–971.
Gregory, A.M., & Sadeh, A. (2012). Sleep, emotional and behavioral difficulties in children and adolescents. *Sleep Medicine Reviews*, *16*, 129–136.
Guerrero, M.D., Barnes, J.D., Chaput, J.P., & Tremblay, M.S. (2019). Screen time and problem behaviors in children: Exploring the mediating role of sleep duration. *International Journal of Behavioral Nutrition and Physical Activity*, *16*, 1–10.
Guram, S., & Heinz, P. (2018). Media use in children: American Academy of Pediatrics recommendations 2016. *Archives of Disease in Childhood: Education and Practice Edition*, *103*, 99–101.
Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: A systematic literature review. *Sleep Medicine Reviews*, *21*, 50–58.
Hirshkowitz, M., Whiton, K., Albert, S.M., Alessi, C., Bruni, O., DonCarlos, L., … & Ware, J.C. (2015). National Sleep Foundation's updated sleep duration recommendations: Final report. *Sleep Health*, *1*, 233–243.
Hisler, G.C., Hasler, B.P., Franzen, P.L., Clark, D.B., & Twenge, J.M. (2020). Screen media use and sleep disturbance symptom severity in children. *Sleep Health*, *6*, 731–742.
Hökby, S., Hadlaczky, G., Westerlund, J., Wasserman, D., Balazs, J., Germanavicius, A., … & Carli, V. (2016). Are mental health effects of internet use attributable to the web-based content or perceived consequences of usage? A longitudinal study of european adolescents. *JMIR Mental Health*, *3*, 1–14.
Keyes, K.M., & Kreski, N. (2020). Is there an association between social media use and mental health? The timing of confounding measurement matters. *JAMA Psychiatry*, *77*, 437.
Kim, S.J., Lee, Y.J., Cho, S.J., Cho, I.H., Lim, W., & Lim, W. (2011). Relationship between weekend catch-up sleep and poor performance on attention tasks in Korean adolescents. *Archives of Pediatrics and Adolescent Medicine*, *165*, 806–812.
Leung, C.Y., & Torres, R. (2021). Sleep duration does not mediate the association between screen time and adolescent depression and anxiety: Findings from the 2018 National Survey of Children's Health. *Sleep Medicine*, *81*, 227–234.
Levenson, J. C., Shensa, A., Sidani, J. E., Colditz, J. B., & Primack, B. A. (2017). Social media use before bed and sleep disturbance among young adults in the United States: A nationally representative study. *Sleep*, *40*(9), zsx113.
Li, X., Buxton, O.M., Lee, S., Chang, A.M., Berger, L.M., & Hale, L. (2019). Sleep mediates the association between adolescent screen time and depressive symptoms. *Sleep Medicine*, *57*, 51–60.
Lissak, G. (2018). Adverse physiological and psychological effects of screen time on children and adolescents: Literature review and case study. *Environmental Research*, *164*, 149–157.
Martin, K.B., Bednarz, J.M., & Aromataris, E.C. (2021). Interventions to control children's screen use and their effect on sleep: A systematic review and meta-analysis. *Journal of Sleep Research*, *30*, e13130.
Mazza, S., Bastuji, H., & Rey, A.E. (2020). Objective and subjective assessments of sleep in children: Comparison of actigraphy, sleep diary completed by children and parents' estimation. *Frontiers in Psychiatry*, *11*, 495.
McMakin, D.L., Ricketts, E.J., Forbes, E.E., Silk, J.S., Ladouceur, C.D., Siegle, G.J., … & Dahl, R.E. (2019). Anxiety treatment and targeted sleep enhancement to address sleep disturbance in pre/early adolescents with anxiety. *Journal of Clinical Child & Adolescent Psychology*, *48*, S284–S297.
Meltzer, L.J., & Mindell, J.A. (2008). Behavioral sleep disorders in children and adolescents. *Sleep Medicine Clinics*, *3*, 269–279.
Muthén, L.K., & Muthén, B.O. (2017). *Mplus user's guide* (8th ed.). Los Angeles, CA: Muthén & Muthén.
Nagata, J.M., Cortez, C.A., Cattle, C.J., Ganson, K.T., Iyer, P., Bibbins-Domingo, K., & Baker, F.C. (2022). Screen time use among US adolescents during the COVID-19 pandemic: Findings from the adolescent brain cognitive development (ABCD) study. *JAMA Pediatrics*, *176*, 94–96.
Nesi, J., Rothenberg, W.A., Bettis, A.H., Massing-Schaffer, M., Fox, K.A., Telzer, E.H., … & Prinstein, M.J. (2022). Emotional responses to social media experiences among adolescents: Longitudinal associations with depressive symptoms. *Journal of Clinical Child & Adolescent Psychology*, *51*, 907–922.
Owens, J., Au, R., Carskadon, M., Millman, R., Wolfson, A., Braverman, P.K., … & O'Brien, R.F. (2014). Insufficient sleep in adolescents and Young adults: An update on causes and consequences. *Pediatrics*, *134*, e921–e932.
Owens, J.A., Spirito, A., & McGuinn, M. (2000). The Children's Sleep Habits Questionnaire (CSHQ): Psychometric properties of a survey instrument for school-aged children. *Sleep*, *23*, 1043–1051.
Page, A.S., Cooper, A.R., Griew, P., & Jago, R. (2010). Children's screen viewing is related to psychological difficulties irrespective of physical activity. *Pediatrics*, *126*, e1011–e1017.
Parent, J., Forehand, R., Pomerantz, H., Peisch, V., & Seehuus, M. (2017). Father participation in child psychopathology research. *Journal of Abnormal Child Psychology*, *45*, 1259–1270.
Parent, J., Sanders, W., & Forehand, R. (2016). Youth screen time and behavioral health problems: The role of sleep

duration and disturbances. *Journal of Developmental and Behavioral Pediatrics*, *37*, 277–284.

Pasch, K.E., Laska, M.N., Lytle, L.A., & Moe, S.G. (2010). Adolescent sleep, risk behaviors, and depressive symptoms: Are they linked? *American Journal of Health Behavior*, *34*, 237–248.

Paulich, K.N., Ross, J.M., Lessem, J.M., & Hewitt, J.K. (2021). Screen time and early adolescent mental health, academic, and social outcomes in 9- and 10-year old children: Utilizing the adolescent brain cognitive DevelopmentSM (ABCD) study. *PLoS One*, *16*, e0256591.

Pesonen, A.K., Räikkönen, K., Paavonen, E.J., Heinonen, K., Komsi, N., Lahti, J., … & Strandberg, T. (2010). Sleep duration and regularity are associated with behavioral problems in 8-year-old children. *International Journal of Behavioral Medicine*, *17*, 298–305.

Reed, H.E., McGrew, S.G., Artibee, K., Surdkya, K., Goldman, S.E., Frank, K., … & Malow, B.A. (2009). Parent-based sleep education workshops in autism. *Journal of Child Neurology*, *24*, 936–945.

Riehm, K.E., Feder, K.A., Tormohlen, K.N., Crum, R.M., Young, A.S., Green, K.M., … & Mojtabai, R. (2019). Associations between time spent using social media and internalizing and externalizing problems among US youth. *JAMA Psychiatry*, *76*, 1266–1273.

Sanders, W., Parent, J., Abaied, J.L., Forehand, R., Coyne, S., & Dyer, W.J. (2018). The longitudinal impact of screen time on adolescent development: Moderation by respiratory sinus arrhythmia. *Journal of Adolescent Health*, *63*, 459–465.

Sanders, W., Parent, J., & Forehand, R. (2018). Parenting to reduce child screen time: A feasibility pilot study. *Journal of Developmental & Behavioral Pediatrics*, *39*, 46–54.

Sanders, W., Parent, J., Forehand, R., & Breslend, N.L. (2016). The roles of general and technology-related parenting in managing youth screen time. *Journal of Family Psychology*, *30*, 641–646.

Scharf, R.J., Demmer, R.T., Silver, E.J., & Stein, R.E.K. (2013). Nighttime sleep duration and externalizing behaviors of preschool children. *Journal of Developmental and Behavioral Pediatrics*, *34*, 384–391.

Schlarb, A.A., Sopp, R., Ambiel, D., & Grünwald, J. (2014). Chronotype-related differences in childhood and adolescent aggression and antisocial behavior – A review of the literature. *Chronobiology International*, *31*, 1–16.

Scott, H., & Woods, H.C. (2019). Understanding links between social media use, sleep and mental health: Recent Progress and current challenges. *Current Sleep Medicine Reports*, *5*, 141–149.

Seabrook, E.M., Kern, M.L., & Rickard, N.S. (2016). Social networking sites, depression, and anxiety: A systematic review. *JMIR Mental Health*, *3*, 1–19.

Strasburger, V.C., Hogan, M.J., Mulligan, D.A., Ameenuddin, N., Christakis, D.A., Cross, C., … & Swanson, W.S.L. (2013). Children, adolescents, and the media. *Pediatrics*, *132*, 958–961.

Vandendriessche, A., Ghekiere, A., van Cauwenberg, J., de Clercq, B., Dhondt, K., Desmet, A., … & Deforche, B. (2019). Does sleep mediate the association between school pressure, physical activity, screen time, and psychological symptoms in early adolescents? A 12-country study. *International Journal of Environmental Research and Public Health*, *16*, 1072.

Vriend, J.L., Davidson, F.D., Corkum, P.V., Rusak, B., Chambers, C.T., & McLaughlin, E.N. (2013). Manipulating sleep duration alters emotional functioning and cognitive performance in children. *Journal of Pediatric Psychology*, *38*, 1058–1069.

Wang, G.H., Xu, G.X., Liu, Z.J., Lu, N., Ma, R., & Zhang, E.T. (2013). Sleep patterns and sleep disturbances among Chinese school-aged children: Prevalence and associated factors. *Sleep Medicine*, *14*, 45–52.

Werneck, A.O., Hoare, E., Stubbs, B., van Sluijs, E.M.F., & Corder, K. (2021). Association of mentally-active and mentally-passive sedentary behaviour with depressive symptoms among adolescents. *Journal of Affective Disorders*, *294*, 143–150.

Wu, X., Tao, S., Rutayisire, E., Chen, Y., Huang, K., & Tao, F. (2017). The relationship between screen time, nighttime sleep duration, and behavioural problems in preschool children in China. *European Child and Adolescent Psychiatry*, *26*, 541–548.

Accepted for publication: 31 May 2023