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Nighttime Media Use in Adolescents with ADHD: Links to Sleep Problems and Internalizing Symptoms

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Abstract

Objective: This study examined nighttime media use in relation to sleep problems and anxiety/depression symptoms in adolescents with attention-deficit/hyperactivity disorder (ADHD).

Methods: Participants were 81 adolescents (69% male) ages 13–17 with ADHD. Adolescents completed measures assessing pubertal development, nighttime media use, circadian preference, and daytime sleepiness. Both adolescents and parents completed measures of sleep duration, sleep problems, and internalizing symptoms.

Results: When summing across media uses (e.g., social networking, playing video games, watching television), the average nighttime media use (after 9:00PM) was 5.31 hours. 63% of adolescents reported obtaining less than 8 hours of sleep on school nights, and this percentage rose to 77% for parent-reported sleep duration. Adolescents obtaining less sleep than recommended had more nighttime media use than adolescents obtaining 8 hours of nightly sleep. Controlling for age, sex, pubertal development, stimulant medication use, and ADHD symptom severity, nighttime media use was associated with shorter sleep duration and increased sleep problems across both adolescent and parent report. Media use was also associated with greater adolescent-reported anxiety and depression, and marginally associated with eveningness circadian preference. In considering specific anxiety dimensions, media use was associated with greater adolescent-reported panic symptoms and parent-reported generalized anxiety disorder symptoms.

Conclusions: Findings suggest that nighttime media use may contribute to sleep problems and comorbid internalizing symptoms in adolescents with ADHD, though additional studies are needed to determine causality, potential bidirectional associations, and underlying mechanisms such as using media to (mis)manage negative emotions. Media use is important to assess and monitor and may be an important intervention target when addressing sleep and internalizing problems, and possible underlying cognitive-emotional processes, in adolescents with ADHD.

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Keywords

ADHD; anxiety; attention-deficit/hyperactivity disorder; daytime sleepiness; comorbidity; depression; multi-tasking; screen time; sleep duration; technology

1. Introduction

There is increasing empirical and clinical interest in the role of technology and media use on adolescent functioning.¹⁻⁴ A recent systematic review found that screen time is associated with poorer sleep in children and adolescents, including shorter sleep duration and delayed sleep timing.⁵ There is also indication that media use is associated with youth internalizing symptoms such as anxiety and depression.^{6,7} However, the vast majority of studies have been conducted in school- and community-based samples,^{4,5} leaving it unknown if media use is associated with sleep and internalizing symptoms in clinical samples of youth with mental disorders such as attention-deficit/hyperactivity disorder (ADHD).

There are several reasons why it is important to examine media use in relation to sleep and functional outcomes in youth with ADHD specifically. First, there is growing evidence that youth with ADHD are particularly prone to excessive media use, perhaps due to altered reinforcement mechanisms⁸. A systematic review recently reported a moderate association between ADHD symptoms and excessive Internet use.⁹ In line with these findings, adolescents with ADHD are more likely than their peers to be classified with Facebook overuse (42.2% and 12.2%, respectively),¹⁰ and ADHD symptoms are also associated with adolescents' time spent playing video games.¹¹ Second, compared to their typically developing peers, youth with ADHD experience more sleep problems^{12,13} and internalizing symptoms.^{14,15} It is important to identify factors that contribute to these comorbidities and may thus be important targets for intervention. For instance, media use may be used as a coping mechanism to relieve stress or (mis)manage negative emotions.¹⁶ If this is indeed the case for some adolescents with ADHD, it may be important in intervention to identify the underlying reasons for nighttime media use and, as warranted, target cognitive-emotional processes and associated maladaptive strategies while also building healthy coping strategies. Third, most studies examining either sleep¹³ or internalizing problems¹⁵ in youth with ADHD have been conducted with school-aged children, even though both sleep and internalizing problems increase in adolescence,^{1,17,18} and adolescents also have increasing independence over the use of electronic media.^{19,20} Fourth, it is important for clinicians working with adolescents with ADHD to understand the potential impact of media use on sleep and emotional functioning. This is especially important since current ADHD practice guidelines do not address sleep (aside from brief mention of comorbidities and potential medication side effects) or technology use.^{21,22} Yet, clinically, parents of children and adolescents with ADHD frequently ask for guidance regarding media/technology use and its potential impact on their child's functioning. Although the growing literature in typically developing samples is certainly important and useful, a documented link between media use and sleep and internalizing problems in adolescents diagnosed with ADHD would be clinically informative.

Accordingly, the primary objective of the present study was to examine nighttime media use in relation to sleep-relevant constructs (i.e., sleep duration, sleep problems, circadian preference, daytime sleepiness) in adolescents diagnosed with ADHD. A secondary objective was to examine nighttime media use in relation to internalizing symptoms (i.e., anxiety, depression). We focused on nighttime media use, as opposed to media use more broadly, since media use in the evening hours before bed has been particularly linked to sleep and internalizing domains in community-based samples.^{7,23} We assessed sleep duration, sleep problems, and internalizing symptoms across adolescent and parent reports, building from previous studies that have almost always used a single (typically adolescent) informant^{4,5} and may thus be limited by mono-informant biases. Since parents may not be optimal informants of their adolescent child's sleep,²⁴ adolescent self-reported sleep was the primary focus in the current study and parent-reported sleep also included to examine whether consistent findings would be identified across raters. Finally, the only other study we are aware of that examined media use in adolescents diagnosed with ADHD considered only Facebook and did not examine media use in relation to sleep or internalizing symptoms.¹⁰ In the present study, we examined electronic media use across multiple devices after 9:00PM and its association with multiple sleep and internalizing domains. Based on extant literature in typically developing samples^{4,5} and youth with ADHD,^{10,25} we hypothesized that nighttime media use would be associated with shorter sleep duration, more sleep problems and daytime sleepiness, greater eveningness circadian preference, and increased internalizing symptoms. We further hypothesized that these associations would be robust across adolescent and parent informants (for sleep duration and internalizing variables) and when controlling for important covariates (i.e., age, sex, pubertal status, stimulant medication use, ADHD symptom severity).

2. Methods

2.1. Participants

Participants were 81 adolescents (69% male) ages 13–17 years diagnosed with ADHD. All participants had an IQ 70 (*Range*=79–132) based on the *Kaufman Brief Intelligence Scale, Second Edition* (KBIT-2).²⁶ Sample characteristics, including ADHD and comorbid diagnoses based on the *Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children* (K-SADS)²⁷ interview conducted separately with the adolescent and his/her parent, are provided in Table 1.

2.2. Procedures

This study was approved by the Institutional Review Board (IRB). Multiple strategies were used to recruit participants over a two-year period, including letters distributed through schools and flyers/e-mails distributed at the institution where the study was conducted. Recruitment materials described a larger study examining sleep in adolescents with ADHD, though the study was not specific to (nor did it target) adolescents with sleep problems. Parents who contacted the research staff in response to these recruitment activities were given additional information and were administered a phone screen to assess initial eligibility. At the inclusion/exclusion evaluation, all parents signed informed consent, and youth provided signed assent. All adolescents were required to meet full *DSM-5* criteria for

ADHD Predominantly Inattentive Presentation or ADHD Combined Presentation on the *K-SADS* interview conducted with the parent to be eligible. Exclusion criteria included autism, bipolar disorder, obsessive-compulsive disorder, or psychosis; possible presence of sleep-disordered breathing, periodic limb movement disorder, or restless leg syndrome; history of epilepsy or head trauma resulting in loss of consciousness; $IQ < 70$; regular high caffeine use (more than one coffee/energy drink or three caffeinated soft drinks per day); highly atypical sleep duration (routinely obtaining < 6 hours of > 9.5 hours on school nights); or obligations that required a bedtime later than 10:00PM or waking prior to 6:00AM. Participants taking stimulant medication were allowed if the family was willing (with prescribing physician knowledge) to discontinue the medication for part of the following summer when the larger study was completed. In the first year all participants taking melatonin or a non-stimulant psychiatric medication were excluded; in the second year these were not exclusionary but were allowable if the family agreed to discontinue the medication during the summer with oversight of the prescribing physician.

2.3. Measures

2.3.1. Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS).—The K-SADS²⁷ is a semi-structured diagnostic interview with good reliability and validity. The ADHD, ODD, anxiety disorders, and mood disorders modules were administered in this study by doctoral students in clinical psychology, postdoctoral fellows, staff with a Master's degree in counseling psychology, and licensed psychologists. All interviewers were trained by experienced interviewers, including scoring a previously recorded interview, observation of interviews, and being observed before interviewing independently.

2.3.2. Pubertal Development Scale (PDS).—The PDS²⁸ is a validated, non-invasive self-report measure assessing pubertal development, with separate forms for males and females. The PDS is more heavily weighted to physical changes in growth and development that occur in mid- to late puberty for both boys and girls²⁹ and was thus appropriate for use in our sample of adolescents ages 13–17. Given associations between puberty and sleep, sleepiness, and circadian preference^{30,31}, pubertal development mean scale score was included as a covariate in regression analyses (girls $\alpha = .83$, boys $\alpha = .78$).

2.3.3. Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS).—The VADPRS³² includes all nine inattentive (ADHD-IN) and nine hyperactive-impulsive (ADHD-HI) *DSM* ADHD symptoms. Each item is rated on a four-point scale (0 = *never*, 3 = *very often*). In the present study, mean scale scores were calculated (ADHD-IN $\alpha = .90$, ADHD-HI $\alpha = .90$) and included as covariates in the regression analyses to ensure findings were not attributable to ADHD symptom severity.

2.3.4. Nighttime Media Use.—The nighttime media use measure developed by Calamaro et al.²³ was used. This questionnaire was developed through content/face validity procedures with experts followed by psychometric evaluation in a sample of adolescents. Participants were first asked if they owned/had in their bedroom a cell phone, television, computer/laptop/tablet, or iPod/MP3 player. Participants were also asked if they used seven

different electronic medias after 9PM and, if so, how many hours they used each electronic media each night: watching television, texting friends, online with friends (social networking), talking on the phone, playing video/computer games or apps, watching DVD/video (including Netflix, Hulu, etc), and listening to iPod/podcast. We summed the number of technologies in each participant's bedroom and also summed the total hours of nighttime (after 9PM) electronic media use for each participant. As in Calamaro et al.,²³ the total media use variable was not normally distributed and was log-transformed for correlation and regression analyses (the non-transformed variable was used for descriptive analyses).

2.3.5. School Sleep Habits Survey (SSHS).—The SSHS³³ is a self-report measure of sleep functioning validated for use in youth ages 10–19 years. In addition to describing the sleep patterns in our sample, the school night sleep duration item was used in primary analyses in addition to the sleep-wake problems scale (15 items assessing irregular sleep habits, prolonged sleep latency, and difficulties waking in the morning) and the morningness-eveningness items (10 items assessing circadian preference, with lower scores indicating extreme eveningness and higher scores indicating extreme morningness). Wolfson et al.³⁴ found that total sleep time as reported on the SSHS did not significantly differ from sleep duration as reported on a daily sleep diary or as estimated using actigraphy. In addition to the school night sleep duration item, mean scale scores were calculated for circadian preference ($\alpha=.72$), daytime sleepiness ($\alpha=.74$), and sleep/wake problems ($\alpha=.78$).

2.3.6. Sleep Disturbance Scale for Children (SDSC).—The SDSC³⁵ is a 26-item parent-report measure of youths' sleep functioning. The SDSC queries regarding sleep duration in addition to items completed on a 5-point scale (1=*never*, 5=*always/daily*) assessing a range of sleep problems. In addition to the sleep duration item, the mean scale score for total sleep problems was calculated ($\alpha=.72$) using 23 items based on recent psychometric research examining the SDSC in a clinical sample of children and adolescents.³⁶

2.3.7. Revised Child Anxiety and Depression Scales (RCADS) and RCADS-Parent Version (RCADS-P).—The RCADS³⁷ and RCADS-P³⁸ is a 47-item measure that assesses anxiety and depression disorder symptoms on a four-point scale (0=*never*, 3=*always*). The RCADS and RCADS-P have good psychometric properties and has demonstrated excellent reliability and validity in clinical and nonclinical samples,^{37,39,40} including in youth evaluated for ADHD specifically.⁴¹ To eliminate potential contamination with the sleep measures, two separation anxiety items (“feel scared to sleep on my own”, “I worry when I go to bed at night”) and one depression item (“I have trouble sleeping”) related to sleep were removed before computing scale scores. In the present study, mean scale scores were calculated and internal consistencies for adolescents (parents) were: generalized anxiety $\alpha=.78$ (.82), social phobia $\alpha=.85$ (.88), panic disorder $\alpha=.79$ (.65), obsessive-compulsive $\alpha=.70$ (.60), separation anxiety $\alpha=.51$ (.30), total anxiety $\alpha=.92$ (.88), and depression $\alpha=.73$ (.67). Given the unacceptably low reliability of the separation anxiety subscale (once the two sleep-related items on this scale were removed), this subscale was not used in analyses examining specific anxiety dimensions.

2.4. Statistical Analyses

First, descriptive statistics for the number of electronic devices in bedroom and nighttime media use were calculated, as well as the percentage of participants who engage in varying hours spent in nighttime media use. Second, independent samples *t*-tests were conducted to examine whether participants with and without recommended sleep duration (separately per adolescent and parent report) differed the number of electronic devices in their bedrooms and/or nighttime media use. Cohen's *d* was computed as a measure of effect size, with 0.2 considered a small effect, 0.5 a medium effect, and 0.8 a large effect.⁴² Third, zero-order correlation analyses were conducted to examine the correlations among the study variables. A correlation of 0.10 is considered a small effect, 0.30 is considered a medium effect, and 0.50 is considered a large effect.⁴² Fourth, multiple regression analyses were conducted to examine the unique effects of nighttime media use in relation to circadian preference, daytime sleepiness, sleep duration, overall sleep problems, anxiety, and depression. Age, sex, pubertal development, stimulant medication use, ADHD-IN symptoms, and ADHD-HI symptoms were included as covariates in all regression analyses. We also conducted multiple regression analyses examining nighttime media use in relation to specific anxiety domains that were significantly bivariately correlated with nighttime media use to determine if these associations remained significant above and beyond covariates. For all regression analyses, Durbin-Watson coefficients were between 1.5 and 2.5 (range: 1.66 to 2.28), indicating that the residuals of independent variables are independent.

3. Results

3.1. Rates of Technology in Bedroom and Nighttime Media Use

As summarized in Table 2, 93% of participants reported owning their own cell phone, with approximately half of participants having a computer/laptop/tablet, television, and/or MP3 player/iPod in their room. Of the four technology devices, 3.7% of participants reported having zero devices, 17.3% reported having only one device, 33.3% reporting having two devices, 30.9% reported having three devices, and 14.8% reported having all four devices.

The average duration of nighttime media use among participants was 5.31 hours ($SD = 4.24$; $Median = 5$ hours)¹, with a range of 0 to 23 hours (note that it is possible, even highly likely, that participants engage in multiple technologies simultaneously that are then summed together for the total nighttime media use duration²). As shown in Table 3, participants reported that they spend approximately one hour after 9:00PM in each of the following media uses: watching DVDs/videos, being online with friends, playing video games, texting, and watching television. It was only approximately 20% of participants who reported less than 2 hours of media use after 9PM, with approximately 60% reporting more than 4 hours of nighttime media use (see Table 3). Although boys and girls did not differ in total

¹Two participants (reporting 19 and 23 hours) were outliers from the rest of the sample that had a range of 0 to 14 hours ($M = 4.91$ hours, $SD = 3.44$ hours, $Median = 4.50$).

²In the original study using this measure, the authors referred to this measure as multi-tasking.²³ However, the measure does not specifically inquire as to the simultaneous use of devices (e.g., it is possible that a participant watches television for an hour, then turns off their television and uses their phone for an hour). Although it is almost certain that at least some (if not most) of the nighttime media use reported in our sample is multi-tasking, we could not be confident that this is the case and for this reason use "nighttime media use" rather than "nighttime multi-tasking" terminology.

nighttime media use duration, two sex differences emerged for specific media use domains: girls reporting spending significantly more time texting than boys (1.53 ± 1.38 and 0.63 ± 0.96 hours, respectively, $t=3.32$, $p=.001$) whereas boys reporting spending significantly more time playing video games than girls (1.22 ± 1.34 and 0.44 ± 0.77 hours, respectively, $t=3.29$, $p=.002$).

63% ($n=51$) of participants reported obtaining less than 8 hours of sleep on school nights, and this percentage rose to 76.5% ($n=62$) when parent report of sleep duration was used. When either adolescent or parent school night sleep duration was used, participants obtaining less sleep than recommended (i.e., 8–10 hours) did not differ from other participants in number of electronic devices in bedroom ($ps>.05$). When adolescent report of sleep duration was used, participants obtaining less sleep than recommended did not report significantly more nighttime media use (5.85 ± 4.61 hours) than participants obtaining recommended sleep duration (4.39 ± 3.40 hours; $t=1.51$, $p=.14$) though the effect size was a small-to-medium effect size difference between groups ($d=.36$). When parent report of sleep duration was used, participants obtaining less sleep than recommended reported significantly more nighttime media use (6.12 ± 4.22 hours) than participants obtaining 8 hours of sleep each night (2.65 ± 3.09 hours; $t=3.31$, $p=.001$), a large effect ($d=.94$).

3.2. Correlation Analyses

Intercorrelations and descriptive statistics of study variables are reported in Table 3. Number of electronic devices in bedroom was not significantly correlated with any of the sleep or internalizing domains (all $ps>.05$). Nighttime media use was negatively correlated with morningness circadian preference ($p=.03$) but was unassociated with daytime sleepiness ($p=.09$). Nighttime media use was significantly correlated with shorter adolescent- and parent-reported sleep duration ($ps=.047$ and $.001$, respectively), more adolescent- and parent-reported sleep problems ($ps=.002$ and $.01$, respectively), and increased adolescent-reported total anxiety and depressive symptoms (both $ps=.03$). Nighttime media use was not correlated with parent-reported total anxiety or depressive symptoms ($ps>.05$). In considering specific anxiety dimensions, nighttime media use was significantly correlated with increased adolescent-reported panic symptoms ($r=.35$, $p=.001$) and parent-reported generalized anxiety disorder symptoms specifically ($r=.22$, $p=.049$).

3.3. Regression Analyses Examining Nighttime Media Use in Relation to Sleep, Sleepiness, and Circadian Preference

As summarized in Table 4, nighttime media use was marginally associated with greater eveningness circadian preference ($p=.051$) and unassociated with daytime sleepiness ($p=.099$) above and beyond age, sex, pubertal development, ADHD medication, and ADHD symptoms. Above and beyond these covariates, nighttime media use remained significantly associated with shorter adolescent- and parent-reported sleep duration ($ps=.04$ and $.004$, respectively). For every standard deviation unit increase in nighttime media use, sleep duration decreased by $.25$ and $.33$ standard deviation units for adolescent- and parent-reported sleep duration, respectively. Nighttime media use likewise remained significantly associated with more sleep problems per both youth and parent report ($ps=.005$ and $.003$, respectively).

3.4. Regression Analyses Examining Nighttime Media Use in Relation to Internalizing Symptoms

As summarized in Table 5, nighttime media use remained significantly associated with increased adolescent-reported depressive and total anxiety symptoms (p s=.01 and .04, respectively), as well as panic symptoms specifically (p =.001), after controlling for age, sex, pubertal development, ADHD medication, and ADHD symptoms. Nighttime media use also remained significantly associated with increased parent-reported generalized anxiety disorder symptoms (p =.04).

4. Discussion

This is the first study to our knowledge to examine nighttime media use in relation to sleep problems and internalizing symptoms in adolescents diagnosed with ADHD. Compared to their peers, adolescents with ADHD experience higher rates of both sleep problems^{12,13} and internalizing symptoms,^{14,15} making it important to identify correlates of these comorbidities. The current study used a multi-informant design and found nighttime media use to be linked to more daytime sleepiness, shorter sleep duration, and greater overall sleep problems, as well as increased internalizing symptoms, in adolescents diagnosed with ADHD. Importantly, these associations were evident even when controlling for a host of other variables, including age, sex, pubertal development, stimulant medication use, and ADHD symptom severity.

As hypothesized, findings provide important evidence for an association between nighttime media use and sleep difficulties in adolescents with ADHD. In addition to nighttime media use being associated with marginally greater adolescent-reported eveningness preference, media use was also associated with shorter sleep duration and sleep problems across both adolescent and parent report. The cross-informant findings are especially noteworthy, not only because it reduces concerns about potential mono-informant biases, but also because parent ratings of adolescents' ADHD symptoms were controlled in analyses. This is thus a stringent test whereby adolescent-reported nighttime media use remained associated with parent-reported sleep outcomes above and beyond other parent-report measures. There are three primary reasons why media use is theorized to impair sleep: (1) media use directly displaces sleep, (2) media use contributes to mental, emotional, and/or physiological arousal, and (3) bright light exposure from media delays circadian rhythm.⁴ To date, the displacement hypothesis has garnered the most empirical support⁴³. Although the current study is not designed to address the relative support for possible mechanisms, our findings are in line with the displacement hypothesis given the association of nighttime media use with both adolescent and parent reports of sleep duration. Further, our findings point to the need for additional research in adolescents with ADHD, particularly for studies that can evaluate possible mechanisms, as well as moderators, of associations. In the meantime, our findings are clinically important since even an hour of shortened sleep can impact functioning,^{44,45} and this is especially relevant for adolescents with ADHD who may experience greater night-to-night sleep variability than their peers.^{12,46} In addition, recent experimental evidence suggests that when adolescents stop using their phones earlier in the evening, they obtain longer sleep, though a low participant recruitment suggests many

adolescents may lack motivation to change their pre-bedtime phone use.⁴⁷ Given the motivational deficits often prevalent in ADHD, coupled with a propensity for excessive technology use, addressing motivation is likely to be an important component to include in the treatment of sleep problems in adolescents with ADHD.⁴⁸

Nighttime media use was also associated with internalizing symptoms in our sample of adolescents with ADHD, though findings were clearer for adolescent-reported rather than parent-reported internalizing symptoms. It is important to note that adolescent self-report is considered important when assessing internalizing states such as anxiety and depression,^{49,50} and media use was associated with greater adolescent-reported anxiety and depressive symptoms. Analyses examining specific anxiety dimensions found nighttime media use to be particularly associated with greater parent-reported generalized anxiety symptoms and youth-reported panic symptoms. This latter association was not expected but on further inspection does have support in theoretical models of media use as well as previous empirical studies in non-ADHD samples. As noted above, physiological arousal has been hypothesized as one mechanism linking media use to sleep problems,⁴ and this hyperarousal may contribute to, or be reflected in, adolescents experiencing more panic symptoms specifically. As noted by Cain and Gradisar,⁴ “media use in the evenings may cause children to become physiologically aroused, making it more difficult for them to relax before bedtime” (p. 741). In line with this possibility, King et al.⁵¹ found adolescents with problematic technology use to have elevated rates of panic disorder, and de Wit and colleagues⁵² found more time spent using technology among adults with panic disorder. More research is needed to evaluate media use in relation to panic symptoms, and our findings point to the importance of specificity in examining specific anxiety dimensions. In addition, it will be important for future research to examine whether daytime internalizing symptoms lead to nighttime media use (perhaps due to using media as a coping strategy for negative emotions), and/or whether nighttime media use leads to internalizing symptoms the following day (perhaps due to social comparisons). Along these lines, it would also be informative for future studies to examine emotional investment in media use⁷ to further tease apart possible reasons for associations found in this study.

4.1. Limitations and Future Directions

Limitations of this study include the cross-sectional design, which prevents drawing causal conclusions. Longitudinal studies are needed to better evaluate causality and directionality, including possible bi-directional and cascading effects. In addition, although both adolescent and parent ratings were used in this study, future studies would benefit from including objective measures of sleep (e.g., actigraphy) and media use. Napping and lights are also highly relevant to the study of technology use and sleep² and were not examined in the current study. Finally, our study did not include a non-ADHD comparison group, and future studies might evaluate whether ADHD status moderates associations between media use and functional outcomes. Interestingly, the school night sleep duration reported by adolescents in this study (7.40 hours) is remarkably similar to the school night sleep duration across North American samples (7.46 hours).⁵³ This suggests that adolescents with ADHD may not differ from their peers in school night sleep duration, though direct comparisons in the sleep of adolescents with and without ADHD are needed, ideally recruited from the same locations

and contexts (e.g., recruiting students from the same schools so that school start time is consistent for all participants). In addition, we were unable to examine parental control, which is important for adolescent media use⁵⁴ and may be especially salient when considering functional outcomes in adolescents with ADHD.⁵⁵ Given our limited sample size, we did not examine specific types of media use, and this is a worthwhile direction for future research.^{2,56} It would also be useful to evaluate nighttime media multitasking or “screen stacking”⁵, as well as sleep hygiene⁵⁷, and their potentially distinct associations with sleep problems and internalizing symptoms in adolescents with ADHD^{58,59}.

4.2. Conclusion

This is the first study to document an association between nighttime media use and more sleep problems and internalizing symptoms in adolescents diagnosed with ADHD. Findings suggest that it is important for clinicians to consider nighttime media use when assessing and treating adolescent ADHD, specifically regarding sleep issues and co-occurring depression and anxiety. Longitudinal studies are required for future research to gain a deeper understanding of the connections between nighttime media usage and sleep, as well as internalizing symptoms, in adolescents with ADHD.

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Table 1

Sample Characteristics (N = 81)

	<i>M ± SD</i>
Age	15.00 ± 1.08
Estimated IQ ^a	103.47 ± 12.21
	<i>N</i> (%)
Sex	
Male	56 (69.1%)
Female	25 (30.9%)
Race/Ethnicity	
White	63 (77.8%)
Black	8 (9.9%)
Asian	1 (1.2%)
Hispanic	1 (1.2%)
Multiracial	8 (9.9%)
Stimulant medication use	29 (35.8%)
Family Income ^b	
Up to \$20,000	3 (3.8%)
\$20,001 - \$40,000	9 (11.3%)
\$40,001 - \$60,000	12 (15.0%)
\$60,001 - \$80,000	9 (11.3%)
Over \$80,000	47 (58.8%)
Psychiatric Diagnoses ^c	Parent Interview / Adolescent Interview / "Or" Rule
ADHD	81 (100%) / 50 (61.7%) / 81 (100%)
Combined Type	19 (23.5%) / 12 (14.8%) / n/a
Inattentive Type	62 (76.5%) / 38 (46.9%) / n/a
Depression/Dysthymia	2 (2.5%) / 1 (1.2%) / 2 (2.5%)
Generalized Anxiety Disorder	3 (3.7%) / 5 (6.2%) / 7 (8.6%)
PTSD	1 (1.2%) / 1 (1.2%) / 2 (2.5%)
ODD	8 (9.9%) / 2 (2.5%) / 8 (9.9%)
CD	1 (1.2%) / 1 (1.2%) / 1 (1.2%)
Any Comorbid Diagnosis	12 (14.8%) / 8 (9.9%) / 15 (18.5%)

Note. ADHD = attention-deficit/hyperactivity disorder. CD = conduct disorder. ODD = oppositional defiant disorder. PTSD = posttraumatic stress disorder.

^a Estimated intelligence quotient (IQ) determined using the *Kaufman Brief Intelligence Scale, Second Edition* (KBIT-2).

^b One parent declined to answer the family income question.

^c Diagnoses established using the *Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children* (K-SADS), with ADHD diagnosis based on interview with the adolescent's parent used for study inclusion.

Table 2

Technology in Bedroom and Nighttime Media Use in Adolescents with ADHD

Technology in Bedroom	Participants, %
Cell phone	92.6%
Computer/laptop/tablet	58.0%
Television	40.7%
iPod/MP3 player	44.4%
Nighttime Media Use Frequency	Participants Engaged in Activity After 9PM, %
Listening to music/podcast	27.2%
Online with friends	56.3%
Playing video/computer games	53.1%
Talking on phone	20.3%
Texting	58.2%
Watching DVDs/videos	63.0%
Watching television	51.3%
Nighttime Media Use Duration (<i>hr</i>)	Hours Spent Doing Activity, $M \pm SD$ (Range)
Media Activities	0.46 \pm 0.94 (0 – 4)
Listening to music/podcast	0.98 \pm 1.28 (0 – 6)
Online with friends	0.98 \pm 1.24 (0 – 6)
Playing video/computer games	0.31 \pm 0.91 (0 – 4)
Talking on phone	0.91 \pm 1.17 (0 – 6)
Texting	1.02 \pm 1.06 (0 – 4)
Watching DVDs/videos	0.73 \pm 1.14 (0 – 8)
Watching television	
Total Nighttime Media Use (<i>hr</i>)	Participants, %
0 hours	6.2%
>0 and <2 hours	13.6%
2 and <4 hours	21.0%
4 and <6 hours	18.5%
6 and <8 hours	18.5%
8 and <10 hours	11.1%
10 hours	11.1%

Note. ADHD = attention-deficit/hyperactivity disorder.

Table 3

Intercorrelations and Descriptive Statistics of Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1. Sex	--																		
2. Age	-.15	--																	
3. Pubertal development	-.39***	.50***	--																
4. ADHD medication use	-.06	.12	.11	--															
5. ADHD-IN	.17	-.15	-.18	-.12	--														
6. ADHD-HI	.10	-.33***	-.28*	-.08	.32**	--													
7. # devices in bedroom	-.03	.20	.17	.24*	-.13	.01	--												
8. Nighttime media use	-.05	.04	.18	.04	-.20	-.16	.34**	--											
9. SR Circadian preference	.17	-.12	-.16	.10	-.003	.25*	.08	-.24*	--										
10. SR Daytime sleepiness	-.28*	.02	.02	-.19	-.05	-.03	-.15	.19	-.51***	--									
11. SR Sleep duration	.07	-.16	-.08	.14	.03	-.06	-.19	-.22*	.20	-.18	--								
12. PR Sleep duration	-.16	.16	.24*	.01	-.02	-.17	.10	.35**	-.31**	.22*	-.42***	--							
13. SR Sleep/wake probs	-.22*	-.04	.11	-.04	-.10	-.06	.12	.34**	-.53***	.61***	-.28*	.33***	--						
14. PR Total sleep probs	-.08	-.10	.07	.01	.30**	.02	.09	.27*	-.36**	.20	-.39***	.46***	.32**	--					
15. SR Depression	-.27*	-.05	.14	.03	.13	.08	-.06	.25*	-.34**	.45***	-.20	.22*	.47***	.35**	--				
16. SR Anxiety	-.21	-.08	.13	.01	.04	-.004	.04	.24*	-.13	.20	.02	.11	.25*	.25*	.67***	--			
87. PR Depression	.08	-.01	-.11	-.01	.29**	-.03	.05	.04	-.09	.02	-.20	.19	.07	.29**	.23*	.19	--		
16. PR Anxiety	.03	.04	.03	.08	.22	-.03	.14	.11	-.02	-.03	.07	.01	-.03	.18	.02	.16	.43***	--	
Mean	--	15.00	3.02	--	2.98	2.02	2.36	5.31	26.32	13.04	7.40	3.16	18.41	37.72	0.56	0.59	0.44	0.37	
Standard Deviation	--	1.08	0.62	--	0.62	0.67	1.05	4.24	4.74	3.31	1.04	0.84	6.15	6.70	0.39	0.34	0.32	0.23	

Note. For sex, 0 = female, 1 = male. For ADHD medication use, 0 = not prescribed stimulant medication, 1 = prescribed stimulant medication. For circadian preference, higher scores indicate greater morningness preference. For pubertal development, higher scores indicate more advanced pubertal development. PR = parent-report. SR = adolescent self-report.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4
 Regression Analyses Examining Nighttime Media Use in Relation to Circadian Preference, Daytime Sleepiness, and Sleep Problems

	Adolescent Report						Parent Report					
	Circadian Preference		Daytime Sleepiness		Sleep Duration		Sleep/Wake Problems		Sleep Duration		Total Sleep Problems	
	β	t	β	t	β	t	β	t	β	t	β	t
Sex	.15	1.30	-.28	-2.56*	.07	.54	-.21	-1.82 [†]	-.11	-.93	-.11	-.94
Age	-.04	-.35	.004	.03	-.23	-1.74 [†]	-.10	-.77	.07	.59	-.14	-1.17
ADHD medication	-.01	-.06	-.21	-1.94 [†]	.05	.34	.02	.17	.10	.71	.09	.72
Pubertal development	.13	1.17	.003	.02	.16	1.44	-.05	-.50	-.02	-.19	.04	.36
ADHD-IN symptoms	-.14	-1.19	.01	.08	.01	.11	-.01	-.08	.13	1.09	.40	3.58***
ADHD-HI symptoms	.24	1.97 [†]	.18	1.67	-.16	-1.27	-.01	-.09	-.10	-.86	-.07	-.58
Nighttime media use	-.22	-1.99 [†]	-.28	-2.56 [†]	-.25	-2.15*	.32	2.92**	.33	3.01***	.32	3.03***

Note. For sex, 0 = female, 1 = male. For ADHD medication use, 0 = not prescribed stimulant medication, 1 = prescribed stimulant medication. For circadian preference, higher scores indicate greater morningness preference. For pubertal development, higher scores indicate more advanced pubertal development. For adolescent reported sleep duration, higher scores indicate longer duration, whereas for parent reported sleep duration lower scores indicate longer duration.

[†] $p < .10$
[†] $p = .051$.
 * $p < .05$.
 ** $p < .01$.
 *** $p < .001$.

Table 5

Regression Analyses Examining Nighttime Media Use in Relation to Internalizing Symptoms

	Adolescent Report						Parent Report	
	Total Anxiety		Panic		Depression		Generalized Anxiety	
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Sex	-.20	-1.64	-.13	-1.12	-.28	-2.47*	.09	.65
Age	-.15	-1.14	-.09	-.69	-.09	-.68	.07	.48
ADHD medication	.10	.72	.16	1.21	.08	.58	-.03	-.20
Pubertal development	.01	.05	.10	.97	.03	.32	.07	.57
ADHD-IN symptoms	.11	.96	.19	1.69 [†]	.21	1.82 [†]	.09	.77
ADHD-HI symptoms	-.004	-.03	.11	.93	.09	.74	.04	.31
Nighttime media use	.24	2.08*	.37	3.43**	.28	2.52*	.25	2.12*

Note. For sex, 0 = female, 1 = male. For ADHD medication use, 0 = not prescribed stimulant medication, 1 = prescribed stimulant medication. For pubertal development, higher scores indicate more advanced pubertal development.

[†] $p < .10$ *

* $p < .05$.

** $p < .01$.

*** $p < .001$.