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Evening Circadian Preference is Associated with Sleep Problems and Daytime Sleepiness in Adolescents with ADHD

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Summary

Adolescence is a developmental period characterized by disruptions in sleep and changes in circadian preferences. Although adolescents with attention-deficit/hyperactivity disorder (ADHD) are at even higher risk of sleep disruption than their peers, no study has examined whether circadian preference is associated with sleep problems and daytime sleepiness in adolescents with ADHD. This study provides an initial test of the hypothesis that greater evening preference would be associated with more sleep problems and daytime sleepiness in adolescents diagnosed with ADHD. Participants were 80 adolescents (69% male) ages 13–17 with ADHD. Adolescents completed measures assessing circadian preference, pubertal development, anxiety/depressive symptoms, and weeknight sleep duration. Both adolescents and parents completed measures of sleep problems and daytime sleepiness. In regression analyses controlling for a number of other variables (i.e., age, sex, pubertal development, ADHD medication use, and ADHD, oppositional defiant disorder, and internalizing symptom severity), greater evening preference was associated with both adolescent-and parent-reported sleep problems and daytime sleepiness. Greater evening preference remained significantly associated with each of these sleep problems and daytime sleepiness when also controlling for weeknight sleep duration. This is the first study to demonstrate evening circadian preference to be associated with both sleep problems and daytime

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sleepiness in adolescents with ADHD. Results indicate that circadian function is important to consider as research examining sleep in adolescents with ADHD continues to advance.

Keywords

attention-deficit/hyperactivity disorder; chronotype; circadian rhythm; morningness-eveningness; sleep duration; sleepiness

Introduction

It is well-established that sleep problems and daytime sleepiness commonly co-occur with attention-deficit/hyperactivity disorder (ADHD) (Becker, 2020; Hiscock & Sciberras, 2019). Meta-analyses have demonstrated that school-aged children (Cortese, Faraone, Konofal, & Lecendreux, 2009) and adults (Díaz-Román, Mitchell, & Cortese, 2018) with ADHD are more likely than their peers without ADHD to have sleep problems, which independently contribute to poorer functioning (Sung, Hiscock, Sciberras, & Efron, 2008). In line with findings from other developmental periods, a growing body of research indicates that adolescents with ADHD experience more sleep problems and daytime sleepiness than adolescents without ADHD (Becker, Langberg, Eadeh, Isaacson, & Bourchtein, 2019; Chiang et al., 2010; Hysing, Lundervold, Posserud, & Sivertsen, 2016). However, relatively less is known about the factors associated with sleep problems in adolescents with ADHD (Becker, 2019; Lunsford-Avery, Krystal, & Kollins, 2016). This is an important area for investigation since adolescents frequently obtain insufficient sleep and experience sleep disturbances, at least in part due to major neurobiological, social, and contextual changes that occur during the adolescent period (Crowley, Wolfson, Tarokh, & Carskadon, 2018).

Both behavioral and physiological factors likely contribute to elevated sleep problems and daytime sleepiness in adolescents with ADHD. For instance, poor sleep hygiene (Martin et al., 2018), technology use (Becker & Lienesch, 2018; Bourchtein et al., 2019), and co-occurring psychopathology symptoms (Langberg et al., 2017; Lycett, Mensah, Hiscock, & Sciberras, 2014) have all been associated with sleep problems or daytime sleepiness in adolescents with ADHD. Some studies have found that medication use is associated with sleep problems in adolescents with ADHD (Mick, Biederman, Jetton, & Faraone, 2000; Stein et al., 2002), whereas others have not (Becker, Langberg, & Evans, 2015; Gau & Chiang, 2009). Studies have yet to examine broader correlates of sleep and sleepiness in adolescents with ADHD, and circadian function is one factor that is especially important to examine.

Circadian function shifts in adolescence as maturational changes impacting homeostatic sleep regulation lead to a circadian phase shift toward eveningness (Jenni, Achermann, & Carskadon, 2005). In nonclinical samples of adolescents, measures of circadian preference are associated with sleep/wake problems and daytime sleepiness (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002; Russo, Bruni, Lucidi, Ferri, & Violani, 2007; Vollmer et al., 2017). Although unexamined in adolescents with ADHD, there is growing evidence that children and adults with ADHD have greater evening preference/later chronotype compared to children and adults without ADHD (Coogan & McGowan, 2017; Imeraj et al., 2012). It

has been theorized that alterations in the circadian timekeeping system is one mechanism underlying the high rates of sleep problems among individuals with ADHD (Coogan, Baird, Popa-Wagner, & Thome, 2016). Two studies have found evening circadian preference to be associated with sleep problems and daytime sleepiness in school-aged children with ADHD (Durmuş, Arman, & Ayaz, 2017; Gruber et al., 2012), but no study has examined these associations in adolescents with ADHD.

There are several reasons why it is important to examine the relation between circadian preference and sleep/sleepiness in adolescents with ADHD specifically. First, adolescents with ADHD frequently experience sleep problems, daytime sleepiness, and variable sleep/wake patterns (Becker, Langberg, et al., 2019; Becker et al., 2015; Langberg et al., 2019; Sung et al., 2008), yet very little is known about factors that are associated with such disturbances in this population. Establishing an association between circadian preference and sleep problems in adolescents with ADHD is an important first step before conducting more intensive longitudinal or laboratory-based studies. Second, sleep habits and behaviors are currently recommended for inclusion as part of the screening process when assessing ADHD in adolescents (DuPaul, Anastopoulos, & Kipperman, 2019). If circadian preference is related to sleep problems and sleepiness in this population, it may be appropriate to directly assess circadian preference in such assessments. Third, and relatedly, our field currently lacks treatment studies to improve sleep problems in adolescents with ADHD, and it is thus unclear the extent to which circadian factors should be included in intervention efforts.

The present study builds upon previous work by examining circadian preference in relation to sleep problems and daytime sleepiness in a clinical sample of adolescents diagnosed with ADHD. This study uses a multi-informant design with both adolescent and parent measures of sleep and sleepiness. This is important since previous studies examining circadian preference in relation to sleep/sleepiness in typically developing adolescents have relied solely on self-reported sleep/sleepiness (Giannotti et al., 2002; Russo et al., 2007; Vollmer et al., 2017), whereas studies examining these associations in school-aged children with ADHD have relied solely on parent-report measures (Durmuş et al., 2017; Gruber et al., 2012). By including multiple raters we can examine whether findings are consistent across informants and also ensure that findings are not due to possible mono-informant biases. In addition, previous studies of children with ADHD (Durmuş et al., 2017; Gruber et al., 2012) did not control for a range of other factors known to impact sleep. In the present study we evaluated the association between circadian preference and sleep/sleepiness controlling for pubertal development, age, sex, ADHD medication use, ADHD symptom severity, oppositional defiant disorder (ODD) symptom severity, and internalizing symptoms. Further, as a robust test of the possible role of circadian preference specifically, weekday sleep duration was also included as a predictor variable in a second set of analyses. We hypothesized that, even when controlling for these variables, greater evening preference would be associated with more sleep/wake problems and more daytime sleepiness in adolescents with ADHD.

Methods

Participants

Participants were 80 adolescents (69% male) aged 13–17 years diagnosed with ADHD, with most participants (88%) between the ages of 14 and 16. All participants had an IQ≥70 (Range = 79–132) based on the Kaufman Brief Intelligence Scale, Second Edition (KBIT-2) (Kaufman & Kaufman, 2004). Based on the Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS) (Kaufman et al., 1997) interview conducted with the adolescent's parent, 61 adolescents met criteria for ADHD predominantly inattentive presentation and 19 adolescents met criteria for ADHD combined presentation. Based on the K-SADS interview conducted separately with the adolescent and his/her parent (using an "or" rule), eight participants met criteria for ODD, seven participants met criteria for generalized anxiety disorder (GAD), two participants met criteria for major depression/dysthymia, two participants met criteria for posttraumatic stress disorder (PTSD), and one participant met criteria for conduct disorder (CD); 15 participants met criteria for at least one comorbid diagnosis. Additional sample characteristics are provided in Table 1.

Procedures

This study was approved by the Cincinnati Children's Hospital Medical Center Institutional Review Board (IRB). Multiple strategies were used to recruit participants for a broader study examining sleep in adolescents with ADHD, including letters distributed through schools and flyers/e-mails distributed in the community and at the institution where the study was conducted. Parents who contacted the research staff were administered a phone screen to assess initial eligibility. At the inclusion/exclusion evaluation, all parents signed informed consent, and youth provided signed assent. The current study utilizes data from the inclusion/exclusion study visit conducted during the school year.

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. As part of the broader study, 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 (e.g., part-time employment) that required a bedtime later than 10:00PM or waking prior to 6:00AM. These latter criteria were used given the broader study's use of an experimental sleep restriction/extension protocol and the importance of recruiting adolescents for whom adherence to the protocol was likely possible. See Becker, Epstein et al. (2019) for additional details.

Measures

Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS).—The K-SADS (Kaufman et al., 1997) is a semi-structured

diagnostic interview with good reliability and validity. The ADHD, ODD, CD, GAD, PTSD, 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.

Pubertal Development Scale (PDS).—The PDS (Petersen, Crockett, Richards, & Boxer, 1988) 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 girls (Dorn & Biro, 2011) and was thus appropriate for use in our sample of adolescents ages 13–17. Given associations between puberty and sleep, sleepiness, and circadian preference (Crowley et al., 2018), pubertal development mean scale score was included as a covariate in regression analyses (girls α=.83, boys α=.77).

Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS).—The VADPRS (Wolraich et al., 2003) includes all 18 inattentive and hyperactive-impulsive DSM ADHD symptoms and all eight DSM ODD symptoms. Each item is rated on a four-point scale (0 = *never*, 3 = *very often*). In the present study, total mean scores were calculated for ADHD symptoms (α=.90) and ODD symptoms (α=.91) and included as covariates in the regression analyses to ensure findings were not attributable to ADHD or ODD symptom severity.

Revised Child Anxiety and Depression Scales (RCADS).—The RCADS (Chorpita, Moffitt, & Gray, 2005) is a 47-item measure that assesses anxiety and depression disorder symptoms on a four-point scale (0=*never*, 3=*always*). The RCADS demonstrates good psychometric properties and has demonstrated excellent reliability and validity (Chorpita et al., 2005). 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, a total mean scale score of the remaining 45 items was calculated (α=.93) and included as a covariate in the regression analyses to ensure findings were not attributable to internalizing symptoms.

School Sleep Habits Survey (SSHS).—The SSHS (Wolfson & Carskadon, 1998) is a self-report measure of sleep functioning validated for use in youth ages 10–19 years. The SSHS includes scales assessing sleep-wake problems (15 items assessing irregular sleep habits, prolonged sleep latency, and difficulties waking in the morning), daytime sleepiness (10 items assessing difficulty staying awake in various situations, though the item regarding sleepiness during driving was removed in the current study since most participants were below driving age), and circadian preference (10 items assessing preference for morningness or eveningness, with lower scores indicating extreme eveningness and higher scores indicating extreme morningness). Sum scale scores were calculated for sleep/wake problems (α=.78), daytime sleepiness (α=.74), and circadian preference (α=.72). In addition, an item asking participants how long they usually sleep on a normal school night (not including time

spent awake in bed) was used in to ensure that findings for circadian preference were not attributable to short sleep duration.

Sleep Disturbance Scale for Children (SDSC).—The SDSC (Bruni et al., 1996) is a 26-item parent-report measure of youths' sleep functioning. The SDSC queries regarding sleep duration in addition to items completed on a five-point scale (1=*never*, 5=*always/daily*) assessing a range of sleep problems over the past six months. In the current study, the seven-item difficulty initiating and maintaining sleep (DIMS) (α=.69) and daytime sleepiness (α=.73) subscales were used, in addition the total sleep disturbance score (α=.73).

Statistical Analyses

All analyses were conducted in IBM SPSS Statistics Version 25. First, 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 (Cohen, Cohen, West, & Aiken, 2003). Next, a series of multiple regression analyses were conducted to examine the unique effects of circadian preference in relation to sleep problems and daytime sleepiness. In the first set of regression analyses, age, sex, pubertal development, ADHD medication use, ADHD symptoms, ODD symptoms, and internalizing symptoms were included as covariates in the regression analyses. In the second set of regression analyses, weekday sleep duration was also included as a predictor variable to ensure that findings for circadian preference were not attributable to shortened sleep duration. All variance inflation factor (VIF) values were below 1.7 (values >10 are typically considered problematic), and all tolerance values were above .50 (values <.10 are typically considered problematic) (Cohen et al., 2003), indicating that the regression models did not suffer from problems with multicollinearity.

A retrospective power calculation using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) was conducted to determine the minimum effect size detectable for a multiple regression with a single outcome and 8 predictors. The power calculation specified that effect sizes greater than $f^2 = .22$ could be detected for a sample size of 80, with alpha set at .05.

Results

Correlation Analyses

Intercorrelations and descriptive statistics of study variables are reported in Table 2. Circadian preference was not significantly correlated with sex, age, pubertal development, ADHD medication use, internalizing symptoms, or total ADHD symptoms (*p*s > .05). The limited age range likely contributed to the lack of a significant association between age or pubertal development in relation to circadian preference in this sample. However, an examination of the two ADHD dimensions found greater morning preference to be associated with greater hyperactive-impulsive symptoms ($r = .27$, $p = .02$) but not inattentive symptoms ($r = .03$, $p = .80$). Lower circadian preference scores (greater evening preference) were significantly correlated with more sleep problems and daytime sleepiness across both adolescent-and parent-report (all *p*s < .01; Table 2).

Regression Analyses

Above and beyond sex, age, ADHD medication use, pubertal development, ADHD symptoms, ODD symptoms, and internalizing symptoms, greater evening circadian preference remained significantly associated with greater adolescent-reported sleep/wake problems and daytime sleepiness (both *p*s < .01) and with greater parent-reported difficulty initiating and maintaining sleep, daytime sleepiness, and total sleep disturbance (all *p*s < .01).

Regression analyses were repeated examining both circadian preference and weekday sleep duration in relation to the sleep problem and daytime sleepiness variables are shown in Table 3. Above and beyond the covariates, circadian preference remained significantly associated with both adolescent-and parent-reported sleep problems and daytime sleepiness (all *p*s < .05). Weekday sleep duration was also significantly associated with adolescent-and parent-reported sleep problems (*p*s < .05). However, although weekday sleep duration was significantly bivariately correlated with adolescent-and parent-reported daytime sleepiness, sleep duration was not significantly associated with daytime sleepiness in the regression analyses (*p*s > .05).

Discussion

This is the first study to our knowledge to examine circadian preference in relation to sleep problems and daytime sleepiness in adolescents diagnosed with ADHD. Adolescents with ADHD experience more sleep problems and daytime sleepiness compared to their peers without ADHD (Becker, Langberg, et al., 2019; Chiang et al., 2010; Hysing et al., 2016), making it important to evaluate factors that may contribute to these problems. The current study found greater evening preference to be associated with both sleep problems and daytime sleepiness, with findings consistent across both adolescent and parent ratings of sleep and sleepiness. Strikingly, evening preference was independently associated with sleep problems and daytime sleepiness even when controlling for a number of other variables, including age, sex, pubertal development, internalizing symptoms, ADHD medication use, and ADHD and ODD symptom severity, as well as weeknight sleep duration.

There is growing interest in understanding circadian function in individuals with ADHD (Coogan & McGowan, 2017). Surprisingly, despite noted changes in circadian functioning in adolescence, studies have yet to examine circadian function in adolescents diagnosed with ADHD. Our study is consistent with studies examining children ADHD (Durmuş et al., 2017; Gruber et al., 2012) in demonstrating that circadian preference is associated with sleep problems and daytime sleepiness in adolescents with ADHD. Although the design of our study does not allow for making causal interferences, it has been hypothesized that altered circadian rhythm contributes to the sleep problems and daytime sleepiness that frequently co-occur with ADHD (Coogan et al., 2016). Since sleep problems and sleepiness are associated with co-occurring mental health problems (Becker et al., 2015) and poorer academic functioning (Langberg, Dvorsky, Marshall, & Evans, 2013) in adolescents with ADHD, it is especially important to identify factors that lead to the development and persistence of sleep problems in this population. Our study finds that circadian preference

may be one such factor that is consistently associated with sleep problems and daytime sleepiness as reported by both adolescents and parents.

This line of research has important clinical implications. As noted by Gruber and colleagues (Gruber et al., 2012), “when assessing a child or adolescent with ADHD, it is necessary to distinguish a physiological sleep problems from a behavioral condition of which the sleep problem is but one of the symptoms” (p. 9). As we assessed self-reported circadian preference, as opposed to a biological measure of circadian rhythm, we cannot disentangle physiological and behavioral sleep problems in the present study. Nevertheless, our findings underscore the importance of examining both circadian preference and function in adolescents with ADHD. For some adolescents with ADHD and co-occurring sleep problems, sleep hygiene and behavioral interventions may be sufficient (e.g., Hiscock et al., 2019; Hiscock et al., 2015). However, if circadian factors contribute to, or exacerbate, sleep problems, more intensive interventions (e.g., Harvey et al., 2018) or circadian-specific interventions (e.g., bright light therapy) may be needed. There are also clinical implications for whether melatonin is used as a hypnotic to induce sleepiness or as a chronobiotic to advance circadian phase (Coogan & McGowan, 2017).

For clinical recommendations and care to advance, there are a number of important directions for future research in this area. First, our study included adolescents with ADHD and did not include a comparison sample of adolescents without ADHD thus a future direction of this work is to examine whether associations between evening preference and sleep problems differ between adolescents with and without ADHD. Studies are needed to examine whether adolescents with ADHD have a later circadian preference/chronotype, as well as a phase delay using objective measures such as dim light melatonin onset, compared to adolescents without ADHD. Second, studies are needed to build upon our findings to evaluate whether circadian preference is associated with functional outcomes in adolescents with ADHD. There is some evidence from typically developing youth that sleep problems mediate the association between evening preference and adjustment (Jiskrova, Vazsonyi, Klanova, & Dusek, 2019), and it would be fruitful to test this hypothesis in adolescents with ADHD. Relatedly, both longitudinal and experimental studies will be needed to advance an understanding of temporal associations and mechanistic processes. Larger-scale studies will also be well-suited to testing more complex models that incorporate identified predictors of sleep problems simultaneously, as well as to test mediators and moderators that drive and impact associations.

Limitations and Future Directions

Strengths of this study include using an adolescent sample diagnosed with ADHD and both adolescent and parent ratings of sleep problems and sleepiness which bolsters confidence in the findings obtained. Limitations include the cross-sectional design, which as noted above prevents drawing causal conclusions. Longitudinal studies are needed to better evaluate 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 circadian phase (e.g., dim light melatonin onset [DLMO]). Given our limited sample size, we were unable to examine

possible sex differences or interactions among study variables in relation to sleep and sleepiness. In addition, our sample had relatively low rates of comorbid diagnoses and our sample was recruited with some study-specific inclusion/exclusion criteria, which may limit generalizability and points to the importance of replication. Larger studies that also include a comparison sample of adolescents without ADHD are needed.

Conclusion

This is the first study to demonstrate evening circadian preference to be associated with both sleep problems and daytime sleepiness in adolescents with ADHD. Of note, results were consistent across both adolescent and parent ratings of sleep problems and sleepiness and also held when controlling for a number of other factors known to impact sleep. Findings indicate that circadian function is important to consider as research examining sleep in adolescents with ADHD continues to advance.

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Table 1

Sample Characteristics

	M* ± *SD
Age	15.01 ± 1.09
Estimated IQ[a]	103.61 ± 12.12
	N (%)
Sex	
Male	55 (68.8%)
Female	25 (31.3%)
Race/Ethnicity	
White	63 (78.8%)
Black	8 (10.0%)
Hispanic	1 (1.3%)
Multiracial	8 (10.0%)
Stimulant medication use	29 (35.8%)
Family Income[b]	
Up to $20,000	3 (3.8%)
$20,001 - $40,000	8 (10.0%)
$40,001 - $60,000	12 (15.0%)
$60,001 - $80,000	9 (11.3%)
Over $80,000	47 (58.8%)

Note. $N = 80$.

[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.

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Table 2

Intercorrelations and Descriptive Statistics of Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sex	--	−.14	−.05	−.40***	.14	.05	−.26*	.17	.07	−.24*	−.29**	−.14	−.02	−.08
2. Age		--	.16	.50***	−.29**	−.20	−.07	−.14	−.11	−.03	.02	−.02	.002	−.11
3. ADHD medication use			--	.09	−.18	−.21	−.01	.11	.12	−.07	−.21	−.17	.14	.02
4. Pubertal development				--	−.26*	−.20	.12	−.14	−.11	.11	.02	.22*	−.03	.10
5. ADHD symptoms					--	.56***	.04	.19	−.10	−.10	−.02	.20	.10	.22*
6. ODD symptoms						--	−.14	.07	−.07	−.10	.001	.20	.06	.16
7. Internalizing symptoms							--	−.17	−.08	.29**	.28*	.24*	.17	.31**
8. Circadian preference								--	.23*	−.51***	−.47***	−.32**	−.37**	−.36**
9. Weekday sleep duration									--	−.34**	−.23*	−.42***	−.28*	−.39***
10. SHS sleep/wake problems										--	.61***	.21	.34**	.35**
11. SHS sleepiness											--	.11	.31**	.21
12. SDSC DIMS												--	.29**	.72***
13. SDSC sleepiness													--	.74***
14. SDSC total														--
Mean	--	15.01	--	3.01	2.48	2.05	0.58	26.35	7.39	18.26	12.00	15.71	9.30	41.65
Standard Deviation	--	1.09	--	0.62	0.54	0.67	0.33	4.75	1.02	6.12	3.32	4.02	3.47	7.09
Minimum	0	13	0	1	1.22	1.00	0.00	16.00	4.50	10.00	9.00	9.00	5.00	28.00
Maximum	1	17	1	4	3.56	4.00	1.44	37.00	9.50	37.00	23.00	26.00	24.00	61.00

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. ADHD = attention-deficit/hyperactivity disorder. DIMS = Difficulties Initiating and Maintaining Sleep. ODD = oppositional defiant disorder. SDSC = Sleep Disturbance Scale for Children. SHS = Sleep Habits Survey.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Regression Analyses Examining Circadian Preference in Relation to Adolescent- and Parent-Reported Sleep Problems and Daytime Sleepiness

	Adolescent Report				Parent Report					
	Sleep/Wake Problems		Daytime Sleepiness		DIMS		Daytime Sleepiness		Total Sleep Disturbance	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*	*β*	*t*
	R^2 = .39		R^2 = .37		R^2 = .37		R^2 = .27		R^2 = .41	
Sex	−.13	−1.19	−.25	−2.32*	.02	0.19	.05	0.43	.08	0.75
Age	−.16	−1.37	.04	0.34	−.14	−1.20	−.02	−0.14	−.21	−1.85
ADHD medication	.01	0.09	−.16	−1.64	−.05	−0.54	.25	2.35*	.18	1.85
Pubertal development	.003	0.03	−.17	−1.40	.28	2.35*	−.07	−0.52	.19	1.62
ADHD symptoms	−.04	−0.30	−.01	−0.09	.14	1.11	.14	1.06	.19	1.59
ODD symptoms	−.07	−0.57	.01	0.10	.16	1.30	.04	0.32	.12	1.07
Internalizing symptoms	.15	1.50	.14	1.36	.16	1.53	.12	1.04	.23	2.31*
Weekday sleep duration	−.25	−2.52*	−.10	−1.01	−.31	−3.07**	−.21	−1.96	−.29	−3.03**
Circadian preference	−.42	−4.12***	−.40	−3.90***	−.23	−2.25*	−.38	−3.38**	−.33	−3.34**

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. ADHD = attention-deficit/hyperactivity disorder. DIMS = Difficulties Initiating and Maintaining Sleep. ODD = oppositional defiant disorder.

* p<.05.

** p<.01.

*** p<.001.