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Clinical Implications of Daytime Sleepiness for the Academic Performance of Middle School Age Adolescents with ADHD

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Abstract

This study investigated the relative impact of total time slept per night and daytime sleepiness on the academic functioning of 100 middle school age youth (*Mage* = 11.9) with Attention-Deficit/Hyperactivity Disorder (ADHD). The primary goal of the study was to determine if total time slept per night and/or daytime sleepiness, as measured by youth self-report on the Pediatric Daytime Sleepiness Scale (PDSS), predicted academic functioning above and beyond symptoms of ADHD and relevant covariates, such as intelligence, achievement scores, and parent education level. Self-reported daytime sleepiness but not self-reported total time slept per night was significantly associated with all academic outcomes. When examined in a hierarchical regression model, self-reported daytime sleepiness significantly predicted parent-rated homework problems and academic impairment and teacher-rated academic competence above and beyond symptoms of ADHD and relevant covariates but did not predict GPA or teacher-rated academic impairment. The implications of these findings for better understanding the association between ADHD and sleep and the functional implications of this relationship are discussed.

Keywords

ADHD; Sleep; Daytime Sleepiness; Academics; School Grades

Sleep disturbances are significantly more common in youth with ADHD in comparison to youth without ADHD (Owens, 2009). Estimated prevalence rates for sleep disturbances in youth with ADHD range from 25 – 50% (Sung et al., 2008; Yoon et al., 2012). The most commonly cited sleep difficulties in youth with ADHD include problems with sleep latency, bedtime resistance, and daytime sleepiness (Chaing et al., 2010; Hvolby et al., 2009; Wiebe, et al., 2012). Importantly, significantly higher levels of sleep disturbance have been documented in youth with ADHD not taking psychotropic medications (Cohen-Zion & Ancoli-Israel, 2004; Stein, Weiss, & Hlavaty, 2012), suggesting that the high prevalence of sleep problems in this population is not simply an artifact of stimulant medication use.

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Although it is clear that youth with ADHD experience higher than expected rates of sleep disturbances, it is unknown whether these disturbances result in increased functional impairment. One domain where the clinical implications of sleep disturbances are particularly relevant is academic functioning. In non-ADHD samples, sleep disturbances are associated with worse cognitive performance, higher rates of internalizing and externalizing behavior problems (Astill et al., 2012), and impairment in academic functioning (Drake et al., 2003; Perez-Chada et al., 2007).

Youth with ADHD exhibit considerable impairment with academic performance and achievement, including significantly lower school grades and achievement scores in comparison to their same-aged peers (Frazier et al., 2007). Interestingly, the mechanisms thought to underlie the academic impairments of youth with ADHD, namely inattention and deficits in executive function, are very similar to the deficits thought to lead to poor school performance in youth with sleep disturbances (Beebe, 2011). Specifically, both symptoms of inattention (Langberg et al., 2011) and deficits in executive function (Miller, Nevado-Montenegro, & Hinshaw, 2012) have been shown to predict the academic achievement of youth with ADHD.

Despite these similarities, almost no research has been conducted examining whether sleep disturbances predict academic functioning in samples of youth with ADHD above and beyond symptoms of inattention. Mayes and colleagues (2008) evaluated the relative impact of ADHD symptoms, sleep, IQ, and neuropsychological functioning on academic achievement in a sample of 412 elementary-age children. In this study, children were not formally evaluated for ADHD however; parent ratings of ADHD symptoms were collected. Sleep was measured using scores generated from a full-night polysomnography (e.g. sleep latency, sleep efficiency, awakenings) and also with subscale scores from the parent-rated Pediatric Behavior Scale (PBS; e.g., difficulty falling asleep, daytime sleepiness, parasomnias). The authors reported that objective (i.e. polysomnography) and subjective (i.e. rating scale) measures of sleep were not significant in the final models predicting math and reading achievement. Intelligence, ADHD symptom ratings and neuropsychological task performance were associated with achievement, with IQ being the single best predictor (Mayes et al., 2008).

In theMayes et al. (2008) study, academic functioning was defined as performance on a standardized achievement test, and the relationship between sleep and achievement was examined in an elementary school age sample. It has been argued that sleep problems are less likely to be detrimental to performance on standardized achievement tests because these tests are administered in one-to-one, controlled environments, where test administrators work to minimize the impact of inattention and to promote motivation (Beebe et al., 2010). Further, the middle childhood period is particularly important for the study of sleep disturbances given that adolescents have more autonomy over sleep behaviors and often have greater sleep restriction on school nights and report higher rates of daytime sleepiness (Beebe, 2011; Drake et al., 2003). Accordingly, it has been suggested that additional research is needed with adolescent samples, and that future research focus on the impact of sleep disturbances on school grades and parent- and teacher-rated academic performance, which are more likely to be impacted by daytime sleepiness (Beebe, 2011). Measurement of daytime sleepiness is considered particularly important because assessment of sleep problems (e.g. parasomnias and sleep-disordered breathing), and hours slept per night, does not fully account for problems with daytime sleepiness (Drake et al., 2003) and therefore, may not entirely capture associated problems with academic functioning (Carskadon et al., 1998; Owens et al., 2000).

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As such, the goal of this paper was to examine the relative contribution of hours slept per night and daytime sleepiness to the academic functioning of adolescents with ADHD. We hypothesized that sleep disturbances would have a detrimental impact on school grades and ratings of academic performance above and beyond symptoms of ADHD and relevant demographic variables.

Method

Participants

The 100 participants included in the present study were in grades 6-8 with an age range of 10 – 14 (*Mage* = 11.91, *SD* = 0.91; see Table 1). Parents/guardians who called research staff to express interest in the study were administered a phone screen. On the phone screen, parents had to indicate that their child had a diagnosis of ADHD *or* had to endorse their child as currently exhibiting at least 4 of 9 DSM symptoms of inattention in order to be scheduled for an inclusion/exclusion evaluation. 205 families called, expressed interest in the study, and completed the phone screen. 147 families were eligible based upon the phone screen and completed the inclusion/exclusion evaluation and 123 met full study criteria and were enrolled. The study was reviewed and approved by the Institutional Review Board (IRB) and parents signed informed consent and youth provided assent.

The inclusionary criteria were: (a) meeting full diagnostic criteria for Inattentive or Combined type ADHD, (b) an IQ of 80 or above as estimated using the Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV; Wechsler, 2003); and (c) not meeting criteria for a primary diagnosis of a pervasive developmental disorder or meeting diagnostic criteria for any of the following: bipolar disorder, psychosis, substance dependence other than tobacco, or obsessive-compulsive disorder. Diagnosis was determined by administration of the parent version of the Children's Interview for Psychiatric Syndromes (P-ChIPS; Weller, Weller, Rooney, & Fristad, 1999) combined with parent and teacher ratings on the Disruptive Behavior Disorders rating scale (DBD; Pelham et al., 1992) and Impairment Rating Scale (Fabiano et al., 2006). Fifty-five percent of the sample met criteria for ADHD-Inattentive Type and 45 percent for ADHD-Combined Type. Twenty-four percent of the sample met criteria for a comorbid Anxiety or Depressive disorder.

Measures

Outcome Measures

School Grades: Report cards were collected for all participants. All of the schools involved in the study used the same scale for grades where A = 4.0, A− = 3.7, B+ = 3.3, B = 3.0, B− = 2.7, etc. Grade point average (GPA) was calculated as the average of participants' core class grades (math, science, history, language arts).

Impairment Rating Scale (IRS; Fabiano et al., 2006): The IRS assesses the severity of problems across multiple functional domains on a scale from 0 (*not a problem/definitely does not need treatment or special services*) to 6 (*extreme problem/definitely needs treatment or special services*). The IRS demonstrates excellent temporal stability and evidence of convergent and discriminant validity and is highly effective in discriminating between children with and without ADHD (Fabiano et al., 2006). The present study used the parent- and teacher-reported items assessing academic functioning.

Homework Problems Checklist (HPC; Anesko, Schoiock, Ramirez, & Levine, 1987): Homework problems were assessed using the 20-item parent-completed HPC. For each item, parents rated the frequency of a specific homework problem on a 4-point Likert scale

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(0 = *never*, 1 = *at times*, 2 = *often*, 3 = *very often*). Higher scores on the measure indicate more severe problems. The HPC Total Score was examined in the present study (α = .95).

Classroom Performance Survey (CPS): The CPS is a teacher-completed measure that consists of 20 Likert-type items rated on a scale from 1 = "always" to 5 = "never". The psychometric properties and factor structure of the CPS were recently examined in a large (*N* = 875) sample of adolescents (Brady et al., 2012). The CPS has two factors, Academic Competence and Interpersonal Competence. Given the focus of the present study on academics, the Academic Competence factor was examined (α = .95).

Predictor Measures

Demographic/Child Characteristics: Academic achievement in reading and math was assessed using the *Wechsler Individual Achievement Test, Third Edition* (WIAT-III; Wechsler, 2009). In addition, parents/guardians completed a demographics questionnaire which provided information about ethnicity, family income, parent education level, child age, and gender.

Disruptive Behavior Disorders Rating Scale (DBD; Pelham et al., 1992): The DBD is a scale that includes all *DSM-IV* symptoms of ADHD. Parents and teachers rate how frequently each symptom occurs on a 4-point Likert scale (0 = *never*, 1 = *occasionally*, 2 = *often*, 3 = *very often*). The DBD produces an Inattention score (sum of the nine inattention items) and a Hyperactivity/Impulsivity score (sum of the nine hyperactive/impulsive items). Internal consistencies were high in the present study for the parent (Inattention α =.92, Hyperactivity/Impulsivity α =. 94) and teacher (Inattention α =.93, Hyperactivity/ Impulsivity α =.96) versions.

Pediatric Daytime Sleepiness Scale (PDSS; Drake et al., 2003): The PDSS was specifically developed and validated as a self-report measure in samples of middle school aged youth to examine the relationship between daytime sleepiness and academic functioning. The PDSS is one of six pediatric sleep measures to meet criteria as "well-established" according to the American Psychological Association (APA) Division 54 evidence-based assessment criteria (Lewandowski, Toliver-Sokol, & Palermo, 2011). The PDSS consists of 8 items loading onto a single factor. Adolescents are asked to rate each item on a scale from 4 (always) to 0 (never). Items are summed to produce a total score with item 3 being reverse scored. An item was added to the PDSS asking adolescents to indicate on average, how many hours they slept each night. Hours slept per night and the PDSS Total Score (α =.96) were examined as predictor variables.

Analytical Approach

A three-tiered analytical approach was used to address the research questions. First, correlation analyses were conducted to examine which demographic, IQ/academic achievement, ADHD, and sleep variables were significantly associated with each of the measures of academic functioning. Variables correlated with an academic outcome variable at $p < .05$ were retained for subsequent analyses.

For each academic outcome, any of the significantly correlated demographic, child characteristic, and ADHD symptom dimension variables were entered simultaneously on Step 1. Note that only those variables that were significant when entered simultaneously on Step 1 are displayed in Tables 2 and 3. Hierarchical regression analyses were then conducted to examine whether any of the sleep variables significantly predicted academic outcomes above and beyond any of the variables that were significant in the Step 1 model.

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Results

Missing Data and Effects of ADHD Subtype and Comorbid Disorders

PDSS ratings were completed by 100 of the 123 participants. In comparing the demographic characteristics of those participants for whom child PDSS data were collected ($N = 100$) to those without ($N = 23$), no differences were found for any of the demographic, child characteristic, or academic outcome variables ($ps > .05$). A one-way ANOVA revealed that youth with ADHD-Inattentive Type and youth with ADHD-Combined Type did not differ significantly on daytime sleepiness, PDSS Total Score, $F(1, 99) = 0.20$, $p = .66$, or on total hours slept, $F(1, 99) = 1.65$, $p = .20$. Further, the PDSS Total Score and total time slept per night were not significantly different when comparing youth with comorbid Anxiety and/or Depressive disorders to you without comorbid internalizing disorders ($F(1, 99) = 2.54$, $p = .11$ and $F(1, 99) = 0.84$, $p = .36$, respectively).

Correlation Analyses

The results of the correlation analyses are presented in Table 1. To summarize, correlations between academic outcomes and the PDSS Total Score and ADHD symptom ratings were consistently significant and in the expected direction. Hours slept each night was not significantly correlated with any of the academic outcomes. Further, there was not a significant relationship between total hours slept and PDSS Total Score, $r = -.04$, $p = .67$.

Regression Analyses

School Grades—ADHD symptoms of inattention was the only variable that significantly, negatively, predicted school grades when all of the variables significant in the bivariate correlations were entered simultaneously on Step 1 (i.e. higher levels of inattentive symptoms predicted lower school grades). When the PDSS Total Score was entered in Step 2, the symptoms of inattention variable remained the only significant predictor, $t(92) = -2.87$, $p = .01$, $\beta = -.29$.

Impairment Rating Scale - Academic Impairment—As shown in Table 2, for the model predicting parent-rated academic impairment, when the PDSS Total Score was entered in Step 2, the parent-rated symptoms of inattention variable $t(97) = 7.93$, $p < .001$, $\beta = -.61$ and the PDSS Total Score $t(97) = 2.40$, $p = .02$, $\beta = -.19$, each remained as significant predictors in the final model, $F(2,927) = 43.98$, $p < .001$, $R^2 = .48$. In the model predicting teacher-rated academic impairment, when the PDSS Total Score was entered in Step 2, the teacher-rated symptoms of inattention variable remained the only significant predictor, $t(92) = 8.78$, $p < .001$, $\beta = .67$.

Homework Problems—As presented in Table 3, parent-ratings of inattentive symptoms and IQ were significantly associated with ratings of homework problems on Step 1. When the PDSS Total Score was entered on Step 2, all three predictors were significant and together accounted for 80.0% of the variance. The overall model was significant, $F(3,96) = 57.04$, $p < .001$, $R^2 = .80$.

Classroom Performance—As presented in Table 4, teacher-ratings of inattentive symptoms was the only variable significantly correlated with the CPS when all of the variables from the bivariate correlations were entered simultaneously on Step 1, $F(1,92) = 160.79$, $p < .001$, $R^2 = .64$. When the PDSS Total Score was entered on Step 2, both predictors were significant and together accounted for 65.9% of the variance. The overall model was significant, $F(2,91) = 87.87$, $p < .001$, $R^2 = .66$.

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Discussion

This study evaluated the impact of total time slept per night and daytime sleepiness on the academic functioning of adolescents with ADHD. This study builds upon prior work by examining the impact of sleep above and beyond relevant demographic and child characteristics, such as intelligence, parent education, and symptoms of ADHD. This study also extends prior work by examining the impact of sleep on multiple indices of academic performance, including GPA and parent and teacher ratings. Adolescent self-reported daytime sleepiness but not self-reported total time slept was significantly, negatively, associated with GPA and parent and teacher ratings of academics (see Table 1). When examined in regression models with demographic variables and symptoms of ADHD, daytime sleepiness remained a significant predictor in the models examining parent ratings of academic impairment and homework problems and teacher ratings of academic competence. Daytime sleepiness did not predict GPA or teacher ratings of academic impairment above and beyond symptoms of ADHD.

It is interesting to consider why daytime sleepiness would predict parent ratings of academic impairment and homework problems and teacher ratings of academic competence but not GPA or teacher ratings of academic impairment. One possible explanation is that daytime sleepiness negatively impacts certain specific aspects of academic functioning but not others. The results of this study demonstrate that daytime sleepiness impacts homework completion and management behaviors (i.e., the Homework Problems Checklist) and classwork completion and class preparation behaviors (i.e. the Classroom Performance Survey). However, GPA reflects a broad combination of students' academic knowledge, test performance, participation, effort, behavior, attendance, and classwork and homework performance (Bowers, 2011). It may be that daytime sleepiness exerts less of an effect on important components of school grades, such as test knowledge and test performance, and that teachers primarily reflect on students' test grades when rating overall academic impairment. Another potential explanation is that in the school setting, problems with sleepiness in adolescents with ADHD are simply overshadowed by problems with inattention. Many studies have documented a strong and significant association between symptoms of inattention and academic performance (e.g. Massetti et al., 2008; Langberg et al., 2011) and this association was replicated in this study. In fact, in this study, symptoms of inattention was the only variable that consistently predicted GPA above and beyond intelligence and achievement scores. Accordingly, the relationship between inattention and academics may be so strong and impairing that the relative or incremental impact of daytime sleepiness on GPA is difficult to detect.

It is important to note that the findings from this study do not address the issue of causality or directionality. It may be that the association between sleep and parent ratings of academics is actually an indirect rather than a direct effect. For example, ADHD symptoms of inattention may mediate the relationship between sleep and academic performance. Further, it is possible that sleep problems are actually caused by ADHD rather than the other way around. It is important to note however, that self-reported hours slept per night was not significantly associated with academic performance in this study, even at the bivariate level (see Table 1). Therefore, the impact of sleep on academics cannot simply be attributed to adolescents obtaining fewer hours of sleep. The difference between these two indices of sleep (i.e. hours slept versus daytime sleepiness) has been noted in prior research, and is largely attributed to the fact that there is considerable variability in the amount of sleep adolescents need to feel rested (Lewandowski et al., 2011).

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Limitations

The sample included in this study consisted of middle school age adolescents with ADHD and the findings may not generalize to middle school age adolescents without ADHD. Additional research is needed that includes both an ADHD group and a control group to determine whether daytime sleepiness impacts academics differently in youth with and without ADHD. While inclusion of a self-report measure of daytime sleepiness is a strength of the study, a stronger design would have been to use a multi-method measurement approach, including parent ratings and objective measures of sleep. Further, it is worth noting that the average self-reported time slept per night in this sample ($M = 8.72$; see Table 1) is relatively high for a sample of young adolescents and may have limited our ability to detect an association between hours slept and academic functioning. In addition, although we examined the relation between stimulant medication use, sleep, and academic outcomes, medication was included as a dichotomous variable. Future research should examine whether certain types of ADHD medications, dosages, or administration procedures (e.g. an additional dose after school) are related to sleep and academics. Finally, information on the presence/absence of sleep disorders was not collected in this study and therefore, it cannot be determined whether specific problems such as sleep disordered breathing or insomnia had an impact on academic performance. Prior research has demonstrated the impact of specific sleep problems on cognitive functioning in non-ADHD samples (e.g. sleep disordered breathing on cognition in overweight adolescents; Beebe, 2010) and future research should examine the role that sleep disorders might play in the academic functioning of adolescents with ADHD.

Conclusion

Our study demonstrates that daytime sleepiness is associated with multiple indices of academic performance in middle school age adolescents with ADHD. Specifically, the findings suggest that daytime sleepiness significantly negatively impacts certain specific aspects of school performance above and beyond symptoms of ADHD, IQ, and achievement scores (homework and classwork completion and management), but does not appear to make a significant contribution to GPA. Given that sleep problems are common in youth with ADHD, additional research is needed to replicate these findings and to evaluate these relationships in longitudinal samples where directionality can be better explored. If additional studies find that daytime sleepiness puts adolescents with ADHD risk for increased functional impairment, then screening and early intervention procedures should be developed (Beebe, 2011). Incorporating screening for sleep disturbances into primary care settings could be a logical next step given that ADHD is primarily identified and diagnosed in primary care settings.

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Table 1

Means, Standard Deviations, Percentages and Correlations between Predictors and Outcomes

Variable	*M(SD)*	School Grades	Parent-rated Academic Impairment	Teacher-rated Academic Impairment	Parent-rated Homework Problems	Teacher-rated Classroom Performance
Child/Family Characteristics						
Age	11.91 (.91)	−.12	−.03	.01	.05	−.06
Gender	77.0% Male	−.03	−.03	−.04	−.03	.07
Race	79% White	.03	.08	.04	.07	.01
Grade	6.87 (.79)	−.08	−.05	−.10	−.02	−.11
ADHD Meds	45.0% on	−.07	**.24***	.13	.08	.15
Par. Education	14.25 (2.47)	**.24***	.02	.16	−.02	−.09
Family Income	65,250 (71,169)	.19	.08	.08	−.05	−.09
Intelligence	98.86 (13.24)	**.39*****	−.15	−.06	**−.32****	−.18
WIAT Reading	97.36 (13.61)	**.36*****	**−.21***	−.09	−.13	−.15
WIAT Math	94.35 (15.92)	**.41*****	**−.22***	−.07	**−.26***	−.17
Parent ADHD & Comorbidity						
ADHD-I	13.01 (5.50)	**−.34****	**.67*****	**.51*****	**.74*****	**.48*****
ADHD-HI	8.47 (5.74)	**−.21***	**.48*****	**.49*****	**.55*****	**.38*****
Anxiety	57.47 (10.68)	−.14	−.06	.24	.03	.14
Depression	57.78 (10.78)	.01	−.22	.05	−.08	.07
Teacher ADHD						
ADHD-I	11.13 (6.45)	**−.58*****	**.43*****	**.71*****	**.42*****	**.80*****
ADHD-HI	7.24 (6.62)	**−.34****	**.27****	**.44*****	**.24***	**.48*****
Adolescent PDSS						
Hours Slept	8.72(1.12)	.12	.02	−.03	−.08	−.06
PDSS Total	15.78 (6.27)	**−.26****	**.37*****	**.34****	**.39*****	**.33****

Note. Parent's Education = total years in school for parents, where 12 = high school degree, 14 = high school plus two years, and 16 college degree; WIAT = Wechsler Individual Achievement Test, Reading scale; PDSS = Pediatric Daytime Sleepiness Scale; ADHD = Attention-Deficit/Hyperactivity Disorder I = inattentive symptoms; HI = hyperactive/impulsive symptoms; Anxiety = Anxious/Depressed subscale from the parent-completed Child Behavior Checklists (CBCL); Depression = Withdrawn/Depressed subscale from the parent-completed Child Behavior Checklist;

$^{*}p < .05$,

** $p < .01$,

*** $p < .001$.

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Table 2

Hierarchical Regression Analyses Predicting Parent-Rated Academic Impairment

	DV: Impairment Rating Scale: Academic Impairment Score							
	Step 1 Model Summary				Step 2 Model Summary			
	B	***SE***	***β***	***t***	***B***	***SE***	***β***	***t***
	$F(1,98) = 78.40^{**}$, $R^2 = .44$.				$\Delta F(2,97) = 5.75^{*}$, $R^2 = .48$, $\Delta R^2 = .03$			
ADHD-I	.23	.03	.67	**8.85****	.21	.03	.61	**7.93****
PDSS Total Score	--	--	--	--	.06	.02	.19	**2.40***

Note. ADHD-I = parent-rated Attention-Deficit/Hyperactivity Disorder inattentive symptoms; PDSS = Pediatric Daytime Sleepiness Scale;

$^{*}p < .05$,

$^{**}p < .01$,

$^{***}p < .001$.

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Table 3

Hierarchical Regression Analyses Predicting Parent-Rated Homework Problems

	DV: Homework Problems Checklist: Total Score							
	Step 1 Model Summary				Step 2 Model Summary			
	B	***SE***	***β***	***t***	***B***	***SE***	***β***	***t***
	$F(2,97) = 78.15^{**}$, $R^2 = .62$.				$\Delta F(3,96) = 6.29^{*}$, $R^2 = .64$, $\Delta R^2 = .03$			
FSIQ	−.25	.06	−.26	**−4.11*****	−.24	.06	−.25	**−4.02*****
ADHD-I	1.69	.15	.72	**11.45*****	1.58	.15	.67	**10.49*****
PDSS Total Score	--	--	--	--	.33	.13	.16	**2.51***

Note. ADHD-I = parent-rated Attention-Deficit/Hyperactivity Disorder inattentive symptoms; PDSS = Pediatric Daytime Sleepiness Scale; FSIQ = Full Scale Intelligence Quotient;

* $p < .05$,

** $p < .01$,

*** $p < .001$.

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Table 4

Hierarchical Regression Analyses Predicting Teacher-Rated Academic Competence

	DV: Classroom Performance Survey: Academic Competence Factor							
	Step 1 Model Summary				Step 2 Model Summary			
	B	***SE***	***β***	***t***	***B***	***SE***	***β***	***t***
	$F(1,92) = 160.79^{***}$, $R^2 = .64$.				$\Delta F(2,91) = 5.97^{*}$, $R^2 = .67$, $\Delta R^2 = .02^{*}$			
ADHD-I	1.08	.09	.80	**12.68*****	1.01	.09	.76	**11.72*****
PDSS Total Score	--	--	--	--	.22	.09	.16	**2.44***

Note. ADHD-I = teacher-rated Attention-Deficit/Hyperactivity Disorder inattentive symptoms; PDSS = Pediatric Daytime Sleepiness Scale;

* $p < .05$,

** $p < .01$,

*** $p < .001$.