Snoring, Sleep Quality, and Sleepiness Across Attention-Deficit/Hyperactivity Disorder Subtypes

Monique K. LeBourgeois, PhD; Kristin Avis, PhD; Michele Mixon, BA; Joe Olmi, PhD; John Harsh, PhD

Study Objectives: To characterize the relationship between pediatric attention-deficit/hyperactivity disorder (ADHD) subtypes, chronic snoring, and indexes of sleep quality and daytime sleepiness.

Design: A cross-sectional design with planned comparisons of ADHD (all subtypes) versus general community controls; ADHD Predominantly Inattentive Type (ADHD-I) versus a group with both ADHD Predominantly Hyperactive/Impulsive Type (ADHD-HI) and ADHD Combined Type (ADHD-C); and ADHD-HI versus ADHD-C.

Setting: Subjects recruited from a pediatric clinic, a university psychology clinic, and the general community.

Participants: Caretakers of 74 children (45 with ADHD, 29 community controls; 53 boys, 21 girls; mean age, 9.6 years; age range, 6 to 16 years). Thirty-two (71.1%) of the children with ADHD were taking stimulant medication and 7 (15.5%) were taking hypnotic medication.

Interventions: N/A.

Measurements and Results: Caretakers completed the Pediatric Sleep Questionnaire (PSQ) and the Children’s Sleep-Wake Scale (CSWS). Only the ADHD-HI diagnosis was associated with an increased likelihood of chronic snoring. Sleep quality was poorer among children with ADHD than controls; however, there were no differences in sleep quality across ADHD subtypes. Sleepiness was greater in children with ADHD, especially the ADHD-I Type.

Conclusions: Chronic snoring may be a correlated feature in only a subgroup of the ADHD population, possibly those more likely to be diagnosed with ADHD-HI. Although children with ADHD have poorer sleep quality and greater daytime sleepiness, these 2 features of ADHD are not closely related.

Key Words: ADHD subtypes, snoring, sleep-disordered breathing, sleep quality, sleepiness, children

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INTRODUCTION

ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (ADHD) IS AMONG THE MOST COMMON OF THE PSYCHOLOGICAL DISORDERS AFFECTING SCHOOL-AGED CHILDREN, WITH PREVALENCE ESTIMATES RANGING FROM 4% TO 12%. The cardinal features of ADHD include inattention, hyperactivity, and impulsivity. The pathophysiology of ADHD is not yet well understood but may involve abnormal functioning of dopaminergic, glutamatergic, and other neurotransmitter systems in the prefrontal cortex and additional brain regions. There are also reports of reduced regional brain volume in children with ADHD relative to healthy controls, with the volume reduction in some brain areas correlated with symptom severity. The Diagnostic and Statistical Manual, Fourth Edition (DSM-IV) identifies 3 subtypes of ADHD: Predominantly Inattentive Type (ADHD-I), Predominantly Hyperactive-Impulsive Type (ADHD-HI), and Combined Type (ADHD-C). Children with ADHD-I have greater problems with persistence of effort and sustained attention than would be expected for normal children of the same age and sex. Children with ADHD-HI have greater difficulties with excessive and inappropriate activity and with impulse control. Children with ADHD-C meet diagnostic criteria for both ADHD-I and ADHD-HI. Subtype classification of ADHD has been a controversial issue. One of several concerns is that ADHD-I may not actually be a subtype of ADHD but, rather, a separate clinical entity.

Disclosure Statement
No significant financial interest/other relationship to disclose.

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compared to children from the general community. A comparison was then made between the ADHD-I type and that of the remaining 2 subtypes taken together to determine whether chronic snoring is a significant factor only among children with an ADHD diagnosis that includes hyperactivity [ADHD-HI and ADHD-C (ADHD-HI/C)]. A further comparison was made between the ADHD-HI and ADHD-C types. The rationale for this comparison is based on the body of findings showing that snoring is strongly associated with behavioral problems (hyperactivity) but weakly, if at all, related to attention problems (attention deficits). It is possible that the link between nocturnal breathing disturbance and ADHD may involve only the ADHD-HI subtype.

The present study also addressed issues concerning the relationship between sleep quality, daytime sleepiness, and subtypes of ADHD. Children with ADHD not differentiated by subtype are commonly reported by caretakers to have low standing on many behavioral dimensions of sleep quality, including going to bed,[17-19] falling asleep,[17,19-23] maintaining undisturbed sleep,[15-23] returning to sleep after awakening,[20] and returning to wakefulness in the morning.[17,20] Both caretaker reports[24,25] and objective assessments[26-27] suggest that children with ADHD also have significantly greater levels of daytime sleepiness. There are several concerns, however, about how these findings on sleep quality and daytime sleepiness should be interpreted. Although polysomnographic evaluation of a small number of cases provided evidence that sleep disturbance is less likely in ADHD without hyperactivity,[28] little has been done to assess whether sleep quality and daytime sleepiness vary across ADHD subtypes. Additionally, the roles of comorbid disorders and use of stimulant medications are not fully understood.[24,29,30] The subjective reports of increased sleep-onset latencies and increased frequency and duration of nocturnal awakenings have not been consistently verified in studies using objective measures.[17,26,31-35] Moreover, caretaker reports are inconsistent and sometimes contradictory with regard to the features of sleep that are problematic. Corkum and colleagues[32] identified several factors that make the existing literature on sleep of children with ADHD difficult to interpret. These include across-study differences in diagnostic criteria and diagnostic procedures, studies with low statistical power, and studies with a variety of methodological and procedural limitations. The across-study differences in caretaker reports are at least partially due to the marked differences in the instruments used to assess sleep quality.

Sleep quality in the present study was measured using the Children’s Sleep-Wake Scale (CSWS),[36,37] which presents an assessment of sleep across 5 different behavioral dimensions (going to bed, falling asleep, maintaining sleep, reinitiating sleep, and returning to wakefulness). It was anticipated that the CSWS would (a) provide confirming evidence of an abnormal sleep-quality profile of children with ADHD, (b) identify possible differences in sleep quality related to ADHD subtypes, and (c) be useful in quantitative analyses of factors associated with poor sleep quality.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Comparison A</th>
<th>Comparison B</th>
<th>Comparison C</th>
<th>Statistical Analysis</th>
<th>Significant Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADHD (n = 45)</td>
<td>Control (n = 29)</td>
<td>ADHD-HI/C (n = 24)</td>
<td>ADHD-HI (n = 8)</td>
<td>ADHD-C (n = 16)</td>
</tr>
<tr>
<td>Mean age, y (SD)</td>
<td>9.8 (2.8)</td>
<td>9.2 (2.5)</td>
<td>10.4 (2.8)</td>
<td>9.4 (2.8)</td>
<td>8.6 (2.3)</td>
</tr>
<tr>
<td>Boys, %</td>
<td>84.4</td>
<td>62.1</td>
<td>90.5</td>
<td>79.2</td>
<td>87.5</td>
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<tr>
<td>Caucasian, %</td>
<td>93.3</td>
<td>100.0</td>
<td>90.5</td>
<td>95.8</td>
<td>87.5</td>
</tr>
<tr>
<td>Medications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stimulant</td>
<td>32</td>
<td>0</td>
<td>17</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Hypnotic</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Chronic illness</td>
<td>13</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>(asthma, allergies)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of T&amp;A infections, no.</td>
<td>18.8 (3.7)</td>
<td>17.5 (3.1)</td>
<td>19.4 (4.6)</td>
<td>18.1 (2.4)</td>
<td>17.1 (2.2)</td>
</tr>
</tbody>
</table>

ADHD refers to attention-deficit/hyperactivity disorder; ADHD-I, inattentive subtype; ADHD-HI/C, hyperactive/impulsive and combined subtypes; ADHD-HI, hyperactive/impulsive subtype; ADHD-C, combined subtype; FET, Fisher’s exact test; T&A, tonsil and adenoid; BMI, body mass index.

**METHODS**

**Participants**

Caretakers of 108 children who were enrolled in a study about working memory and ADHD[38] were asked to participate in an additional investigation concerning their children’s sleep. Data from 74 children were included in the present analyses. Of the 34 excluded cases, 13 failed to complete at least 1 of the questionnaires, and 21 refused to participate. Children in the ADHD group were recruited from 2 clinical sources: a university school psychology clinic and a local pediatric clinic. The assessment process at both clinics met DSM-IV guidelines[39] and Barkley’s[40] suggestions for appropriate assessment practices in the diagnostic process for ADHD. The assessment protocols were multi-method (behavioral observations, clinical interviews, administration of standardized rating scales, IQ tests, and achievement tests) and multi-informant (caretaker, teacher, and child). To receive an ADHD diagnosis, the primary behaviors associated with ADHD (impulsivity, distractibility, and inattentiveness) must have been evidenced across settings, typically home and school. A team of professionally trained personnel conducted all assessments, and clinic directors (pediatrician or psychologist) made all diagnoses. All children with ADHD met DSM-IV criteria. Children with ADHD and comorbid learning disorders were not recruited for inclusion into the working-memory study[38] to allow for the independent assessment of memory processing associated with ADHD. Children with learning disorders were defined as those who qualified under an intelligence-achievement discrepancy model (eg, measure of IQ greater than 85, measure of achievement less than 90, and at least a 15-point discrepancy between IQ and achievement scores). Thus, children with ADHD and a history of learning disorders were also excluded from participation in the present study. Children with other comorbid psychiatric diagnoses and chronic medical conditions were not excluded.

The control group consisted of children from the local community who were neither referred nor receiving treatment for any behavioral, learning, or psychiatric disorders and who were not taking any medications known to affect sleep (eg, stimulants, antihistamines). Control children were recruited from the local community by information posters and through personal referrals made by existing participants.

Table 1 presents the number and characteristics of children with ADHD (all subtypes) and control children. The overall sample consisted of 74 participants (56 males, 18 females) aged 6 to 16 years (mean, 9.6 ± 2.7 years). Ninety-six percent of the children were Caucasian, and 4% were African-American. The ADHD group included a significantly higher proportion of boys than the control group. Only children with ADHD were taking stimulant medication (71.1%), hypnotic medication (15.6%), or both (8.8%). The number of children with chronic illnesses (eg, asthma, allergies) was similar for ADHD and control children and across ADHD subtypes. A positive history of tonsil and adenoid infections, however, was significantly more likely in children with ADHD-I (42.8%) than in children with ADHD-HI/C (16.7%). A total of 5 children...
with ADHD had comorbid psychiatric diagnoses, including depression, obsessive-compulsive disorder, oppositional defiant disorder, and bipolar disorder. There were no significant differences in the number of children with comorbid psychiatric disorders across ADHD subtypes A(DHD-HI [n = 1], ADHD-I [n = 2], ADHD-C [n = 2]). Referral sources (psychology and pediatric clinics) yielded approximately the same number of children diagnosed with each ADHD subtype.

MEASURES

Pediatric Sleep Questionnaire

The Pediatric Sleep Questionnaire (PSQ) is a pencil-and-paper screening tool that assesses symptom complexes associated with sleep-related breathing disorders in 2- to 18-year-old children.39 Using the past month as a reference period, caretakers report either “yes,” “no,” or “don’t know” to questions measuring symptom domains, including snoring, daytime sleepiness, and inattentive/hyperactive behavior. Chervin et al39 presented reliability and validity data for 3 scales: snoring (4 items), sleepiness (4 items), and behavior (6 items). The scale scores represent the proportion of items with an affirmative response (0 to 1). The scales have adequate internal consistency (α = 0.66 to α = 0.89) and test-retest reliability (r = 0.66 to r = 0.92) for research instruments and effectively discriminate between children with and without sleep-related breathing disorders.

Chervin and colleagues14 found that mean scores on the 4-item PSQ Snoring scale did not reliably differentiate between children with and without ADHD. The PSQ Snoring scale contains items assessing both frequency (“snores more than half the time; always snores”) and quality of snoring (“snores loudly; heavy breathing”). Several reports13,14,40 have shown that snoring frequency is associated with ADHD and hyperactive behavior. Furthermore, Guillemainault and Pelayo12 have opined that chronic snoring is clinically significant because of its association with reduced daytime functioning. Thus, the present analysis focused exclusively on the 2 PSQ items measuring frequency of snoring (chronic snoring).

Given that a factor analysis39 supports use of a 2-item sleepiness scale (caretaker- and teacher-reported sleepiness) and that the remaining 2 PSQ Sleepiness items (waking unfreshened in the morning; hard to wake up) are highly redundant with the CSWS Returning to Wakefulness subscale (see below), sleepiness in the present study was evaluated without the latter 2 items.

Children’s Sleep-Wake Scale

The CSWS is a 40-item pencil-and-paper research instrument that assesses children’s sleep quality along 5 behavioral dimensions: going to bed, falling asleep, maintaining sleep, reinitiating sleep, and returning to wakefulness. By design, the scale does not inquire about symptoms of pediatric sleep disorders (eg, obstructive sleep apnea syndrome, periodic limb movements). The CSWS subscales and the CSWS total sleep quality scale (average of the subscale scores) have adequate internal consistency for research instruments (α = 0.84 to α = 0.90). Details concerning the model upon which the scale is based, scale development, content validity, internal consistency, and construct validity issues are presented in earlier reports.36,37 The version of the CSWS used in this study required parents to report how frequently during the past month their child exhibited different sleep-related behaviors using a 5-point response set (never, not often, sometimes, often, always). A do not know response was an option. Scores on each of the 5 CSWS subscales and the CSWS total Sleep Quality scale range from 1 (poor sleep quality) to 5 (good sleep quality). Four of the CSWS items require parents to quantitatively estimate (in minutes) the following: (a) time bedtime is delayed, (b) sleep-onset latency, and (c) time to fully return to wakefulness in the morning. Parents are also asked to report their children’s typical weekday and weekend bedtimes and rise times.

Procedure

Student researchers made face-to-face or telephone contact with potential participants and asked for help with a study about differences in the sleep patterns of children with and without ADHD. Caretakers who decided to participate signed an institutional review board-approved consent form and completed a general demographics questionnaire, the PSQ, and the CSWS. All data were collected between August 2000 and May 2001.

Analysis

Statistical analyses included 3 sets of planned orthogonal comparisons (a) ADHD (all subtypes) versus control children, (b) ADHD-I versus ADHD-HI/C, and (c) ADHD-HI versus ADHD-C type. Where appropriate, summary measures were presented as means and SD. Comparisons involving continuous variables were made using t or Mann-Whitney U tests. Categorical data were analyzed using a χ² test or a Fisher’s exact test. The significance level for the described comparisons was set at .05. All unplanned comparisons were conducted with a significance level of .01.

RESULTS

Behavior Scale of the PSQ

Caretakers of children with ADHD endorsed a greater proportion of items on the PSQ Behavior scale than did caretakers of control children (see Table 2). All ADHD subtype comparisons for the PSQ Behavior scale scores were nonsignificant. That is, the same high level of endorsement of the PSQ Behavior scale items was found for the Inattentive, Hyperactive, and Combined subtypes.

Chronic Snoring and ADHD Subtypes

Table 2 presents the proportion of subjects in each group with chronic snoring (ie, snore more than half the time or always snore). Although children in the ADHD group were more likely to have chronic snoring (22.5%) than children in the control group (10.7%), and chronic snoring was more common in the ADHD-HI/C group (31.8%) than in the ADHD-I group (11.1%), these differences were not statistically significant. The difference between the ADHD-HI group and the ADHD-C group, however, was significant (P < .05). That is, chronic snoring was found in 62.5% of children with ADHD-HI and only 14.3% of children with ADHD-C.

Table 2—Group and subgroup comparisons of item responses and scale scores on the Pediatric Sleep Questionnaire

<table>
<thead>
<tr>
<th>PSQ Subscales</th>
<th>Comparison A</th>
<th>Comparison B</th>
<th>Comparison C</th>
<th>Statistical Analysis</th>
<th>Significant Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADHD (n = 45)</td>
<td>Control (n = 29)</td>
<td>ADHD-I (n = 21)</td>
<td>ADHD-HI/C (n = 24)</td>
<td>ADHD-HI (n = 8)</td>
</tr>
<tr>
<td>Mean Behavior (SD)</td>
<td>.79 (.21)</td>
<td>.26 (.32)</td>
<td>.78 (.20)</td>
<td>.81 (.21)</td>
<td>.88 (.19)</td>
</tr>
<tr>
<td>Chronic Snoring, %</td>
<td>22.5 (9/40)</td>
<td>10.7 (3/28)</td>
<td>11.1 (2/18)</td>
<td>31.8 (7/22)</td>
<td>62.5 (5/8)</td>
</tr>
<tr>
<td>Sleepiness, %</td>
<td>40.9 (18/44)</td>
<td>7.1 (2/28)</td>
<td>52.4 (11/21)</td>
<td>30.4 (7/23)</td>
<td>25.0 (2/8)</td>
</tr>
</tbody>
</table>

ADHD refers to attention-deficit/hyperactivity disorder; ADHD-I, inattentive subtype; ADHD-HI/C, hyperactive/impulsive and combined subtypes; ADHD-HI, hyperactive/impulsive subtype; ADHD-C, combined subtype; FET, Fisher’s exact test.
Daytime Sleepiness and Sleep Quality

Table 2 shows the proportion of children in each group reported by either a caretaker or a teacher as sleepy. Sleepiness was significantly more common among children with ADHD than among control children (40.9% versus 7.1%; \( P < .001 \)), and this effect remained even when the 7 ADHD children using hypnotic medication were removed from the analysis (32.4% versus 7.1%; \( \chi^2 = 6.0, P < .05 \)). Although sleepiness was more likely to be reported in children with ADHD-I (52.4%) than in those with ADHD-HI/C (30.4%), this difference was not significant. It should be noted, however, that both a caretaker and a teacher reported 11 of the children with ADHD as sleepy. Of these 11 children, 9 were diagnosed with ADHD-I (42.9% of all ADHD-I children) and 2 were diagnosed with ADHD-HI/C (8.7% of all ADHD-HI/C children). This difference was significant (\( P < .05 \)). Statistical significance was also found for this relationship after excluding children taking hypnotic medication (Fisher's exact test, \( P < .05 \)). Daytime sleepiness in children with ADHD was not significantly correlated (Spearman correlation coefficient) with any of the CSWS subscales.

Bedtime and wake time on weekdays and weekends were statistically the same across all groups (see Table 3). Children with ADHD (all subtypes) were rated significantly lower by caretakers on the Going to Bed, Falling Asleep, and Returning to Wakefulness subscales of the CSWS than were children in the control group (See Table 3). The differences in the ADHD and control groups on the Maintaining Sleep subscale approached significance (\( P = .055 \)). Ratings were especially low on the Going to Bed and Falling Asleep subscales, where 59.1% and 56.8%, respectively, of the children with ADHD were below the first quartile for the control children. As shown in Table 3, caretaker estimates of sleep-onset latency were also longer for children with ADHD (24.7 minutes) than for control children (14.9 minutes; \( P < .01 \)), and Problems Returning to Wakefulness were further indicated by a longer estimated time to fully awaken in the morning (19.3 minutes versus 10.4 minutes, respectively; \( P < .05 \)). No CSWS subscale differences were found between children with ADHD taking (n = 31) and not taking (n = 13) stimulant medication. Children with ADHD who were taking hypnotic medication (n = 7), however, had significantly lower scores on the Maintaining Sleep subscale than did those not taking hypnotic medication (n = 37) (2.9 versus 3.6; \( P < .05 \)). Although there were no significant differences across ADHD subtypes on the CSWS subscales, the difference between the ADHD-HI and ADHD-C groups on the Going to Bed subscale approached significance (\( P = .065 \)). The CSWS Sleep Quality subscale scores of children with ADHD who chronically snore (n = 8) were compared to those of the remaining children (n = 31) to assess whether the presence of snoring accounted for sleep-quality differences. Differences were found only on the CSWS Maintaining Sleep subscale: the mean score for chronic snorers was about 1 SD lower than that of children who did not chronically snore (3.0 versus 3.7; \( t = 2.86, P < .01 \)).

**DISCUSSION**

In summary, (a) reports of chronic snoring did not differ between ADHD and control children but were more common among children with ADHD-HI relative to other subtypes and to non-ADHD controls; (b) in comparison to controls, sleep quality was described as poorer among children with ADHD; however, there were no differences in sleep quality across ADHD subtypes; (c) reported sleepiness was more common in children with ADHD than in controls; (d) sleepiness reports by both a caretaker and teacher were more likely among children with ADHD-I than among other subtypes; and (e) the lower sleep quality of children with ADHD was related to but not fully explained by snoring and use of medications.

The finding of greater prevalence (62.5%) of chronic snoring among children diagnosed with ADHD-HI is based upon a small sample, and further studies with larger samples are needed. This relationship is not surprising, given compelling evidence that hyperactivity and behavioral problems are linked to snoring in children. The causal significance of the link between snoring and hyperactivity is not fully understood. Studies describing favorable changes in behavioral assessments and improved academic performance following adenotonsillectomy suggest that sleep-disordered breathing has a negative and reversible effect on daytime functioning in children. Chronic snoring independent of OSAS may also have significant negative effects on behavior. Nevertheless, it cannot be ruled out that snoring and mild sleep-disordered breathing are simply features of ADHD. That is, the pathophysiology underlying daytime hyperactivity and impulsivity related to ADHD may involve areas of the brain also involved in regulation of the upper airway during sleep. This appears to be the case in other central nervous system disorders that are associated with an increased prevalence of sleep apnea.

The ADHD subtype comparisons in this study suggest that chronic snoring may not be related to the Inattentive and Combined subtypes of ADHD. Notably, the prevalence of chronic snoring for the ADHD-I and ADHD-HI subtypes was compared to the ADHD-C subtype, and no differences were found. This is consistent with a recent study in which chronic snoring was associated with ADHD-HI rather than ADHD-C.

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### Table 3—Group and subgroup comparisons of sleep schedules and measures of sleep quality from the Children's Sleep-Wake Scale

<table>
<thead>
<tr>
<th>Comparison A</th>
<th>ADHD n = 45</th>
<th>Control n = 29</th>
<th>ADHD-I n = 21</th>
<th>ADHD-HI/C n = 24</th>
<th>ADHD-HI n = 8</th>
<th>ADHD-C n = 16</th>
<th>Statistical Analysis</th>
<th>Significant Comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekday bedtime</td>
<td>21:06 (.40)</td>
<td>20:57 (.46)</td>
<td>21:04 (.44)</td>
<td>21:09 (.37)</td>
<td>21:08 (.37)</td>
<td>21:10 (.38)</td>
<td>t = -3.7, P &lt; .001</td>
<td>A</td>
</tr>
<tr>
<td>Weekday wake time</td>
<td>6:29 (.35)</td>
<td>6:34 (.24)</td>
<td>6:32 (.35)</td>
<td>6:26 (.37)</td>
<td>6:24 (.20)</td>
<td>6:28 (.43)</td>
<td>t = -2.8, P &lt; .01</td>
<td>A</td>
</tr>
<tr>
<td>Weekend bedtime</td>
<td>22:21 (.54)</td>
<td>22:06 (.01)</td>
<td>22:27 (.00)</td>
<td>22:16 (.47)</td>
<td>22:00 (.30)</td>
<td>22:24 (.53)</td>
<td>t = -1.95, P = .065</td>
<td>Marginal C</td>
</tr>
<tr>
<td>Weekend wake time</td>
<td>8:26 (1:13)</td>
<td>8:07 (.56)</td>
<td>8:33 (1:14)</td>
<td>8:20 (1:12)</td>
<td>7:51 (.28)</td>
<td>8:34 (1:23)</td>
<td>t = -3.0, P &lt; .01</td>
<td>A</td>
</tr>
<tr>
<td>CSWS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>t = -1.95, P = .055</td>
<td>Marginal A</td>
</tr>
<tr>
<td>Total sleep quality</td>
<td>3.5 (.6)</td>
<td>3.5 (.4)</td>
<td>3.5 (.6)</td>
<td>3.3 (.6)</td>
<td>3.6 (.6)</td>
<td>3.6 (.6)</td>
<td>t = -2.2, P &lt; .05</td>
<td>A</td>
</tr>
<tr>
<td>Going to bed</td>
<td>3.1 (.9)</td>
<td>3.7 (.8)</td>
<td>3.1 (.9)</td>
<td>3.0 (.9)</td>
<td>2.9 (.9)</td>
<td>3.2 (.9)</td>
<td>t = -1.95, P = .065</td>
<td>Marginal A</td>
</tr>
<tr>
<td>Falling asleep</td>
<td>3.6 (1.0)</td>
<td>4.2 (.7)</td>
<td>3.6 (1.0)</td>
<td>3.6 (.9)</td>
<td>3.3 (.7)</td>
<td>3.6 (1.0)</td>
<td>t = -3.0, P &lt; .01</td>
<td>A</td>
</tr>
<tr>
<td>Maintaining sleep</td>
<td>3.5 (9)</td>
<td>3.8 (.6)</td>
<td>3.5 (1.0)</td>
<td>3.5 (.9)</td>
<td>3.4 (1.2)</td>
<td>3.5 (.7)</td>
<td>t = -1.95, P = .055</td>
<td>Marginal A</td>
</tr>
<tr>
<td>Reinitiating sleep</td>
<td>4.5 (.6)</td>
<td>4.6 (.5)</td>
<td>4.3 (7)</td>
<td>4.5 (5)</td>
<td>4.4 (.7)</td>
<td>4.5 (4)</td>
<td>t = -2.2, P &lt; .05</td>
<td>A</td>
</tr>
<tr>
<td>Returning to wakefulness</td>
<td>3.0 (1.0)</td>
<td>3.5 (.8)</td>
<td>3.1 (1.1)</td>
<td>3.0 (.9)</td>
<td>3.1 (1.0)</td>
<td>3.0 (.9)</td>
<td>t = -2.2, P &lt; .05</td>
<td>A</td>
</tr>
</tbody>
</table>

Data are displayed as mean (SD).

ADHD refers to attention-deficit/hyperactivity disorder; ADHD-I, inattentive subtype; ADHD-HI/C, hyperactive/impulsive and combined subtypes; ADHD-HI, hyperactive/impulsive subtype; ADHD-C, combined subtype; CSWS, Children’s Sleep-Wake Scale.
ADHD-C groups (11.1% and 14.3%, respectively) approximated reports among (a) the community control group in the present analysis (10.7%), (b) the clinical control groups in the Chervin et al4 study (9% and 11%), and (c) the study groups reviewed by Schechter et al.11 Additionally, the prevalence of chronic snoring in the current study was statistically the same in the ADHD group (all subtypes) and in the control group. This finding is consistent with the reports of other investigators who failed to find a relationship between increased snoring and undifferentiated ADHD19,25 but is at variance with the results of Chervin and colleagues.14 In their study, children with ADHD not differentiated by subtype were approximately 3 times more likely to habitually snore (ie, snore more than half the time) than control children. The discrepant outcomes may be related to differences in sampling strategies. That is, Chervin et al’s sample included preschool children, and the link between snoring and hyperactivity is reportedly stronger in younger children (specifically, in boys less than 8 years of age).13 The ADHD-HI diagnosis is also more common among younger children.45-47 Thus, the greater difference in habitual snoring between ADHD and control groups in the Chervin et al study (33% versus 9% or 11%) and the present study (22.5% versus 10.7%) may be due to differences in the representation of young children.

Children with ADHD had lower scores (more difficulty) on the Going to Bed, Falling Asleep, Maintaining Sleep, and Returning to Wakefulness subscales of the CSWS and reportedly took longer to fall asleep at the beginning of the night and to return to wakefulness in the morning. These findings are consistent with those in many earlier reports that ADHD is associated with sleep problems.17-23 The present study provides no clear indication that sleep quality varies across ADHD subtypes. The sleep-quality differences between ADHD and control children cannot be fully explained by snoring, which was related only to the Sleep Maintenance subscale. The lower standing on the Sleep Maintenance subscale is consistent with previous findings that snoring is related to restless sleep.46 In some children, primary snoring or sleep-disordered breathing may lead to poor sleep maintenance (ie, increased arousals and awakenings), or restless sleep may predispose some children to snoring.

Use of stimulant medications cannot be ruled out as an important influence on sleep quality in the present study. Although no differences were found between children with ADHD who were taking and those not taking stimulant medication, assessing medication effects requires an experimental design with adequate sample size. Previous reports have found that use of stimulants by children is associated with at least mildly disturbed sleep, especially prolonged sleep latency,29,30,32,49 The failure to find a stimulant effect here for the Falling Asleep, Maintaining Sleep, and Reinitiating Sleep subscales may be due to a small effect coupled with the limited number of nonmedicated cases. Notably, other investigators using caretaker and self-reports, as well as objective measures, have found evidence of disturbed sleep in unmedicated children with ADHD,19,35 The common reports of more sleepiness among ADHD than among control children is consistent with findings from previous studies.24-27

Poor sleep quality was not an explanatory factor in the present analysis. It is not clear from the present study why children with ADHD-I were more likely to receive sleepiness ratings by both a caretaker and a teacher than were children with the other ADHD subtypes. Clinically, this finding is not surprising when considering the behavioral presentation of the Inattentive subtype. Children with ADHD-I are most often described as passive, drowsy, sluggish, or a combination thereof when compared to children with hyperactivity.50 In addition, teachers have reported children with ADHD-I as lethargic and daydreamy in class and slower in completing academic tasks.51,52

This study has several limitations. The degree to which clinicians adhere to DSM-IV criteria in the diagnosis of ADHD is known to vary greatly.53 Although the referring clinicians in the present study were experienced and based their ADHD diagnoses on extensive and multidimensional assessments, their strict adherence to DSM-IV criteria was not objectively established. It is possible that clinical practices such as a reluctance to consider an ADHD diagnosis in children suspected of having obstructive sleep apnea syndrome may have resulted in an underrepresentation of habitually snoring children in our sample. With regard to the ADHD-group versus control-group comparisons, there is a concern that the differences observed may be related to unequal sex distribution in the 2 groups. The small number of children with ADHD-HI presents another limitation. The prevalence rate of ADHD-HI is the lowest of the ADHD subtypes.54 Although our finding of increased snoring with this subtype is consistent with the literature showing a snoring-hyperactivity relationship, a larger sample will be needed to obtain an accurate estimate of the prevalence and severity of chronic snoring. The use of medication by children in the ADHD group is a further limitation. Medication status is unlikely to fully account for the altered amount and pattern of sleep quality associated with ADHD; however, further study of this complex relationship is needed. Finally, this study used caretaker reports to assess sleep, sleepiness, and daytime functioning, which raises well-known validity issues. The discrepancies between subjective and objective assessments of sleep problems are not fully understood.32 Also, the sleepiness measure from the PSQ was especially limited because presence but not severity of sleepiness was assessed and, further, the scale was based on only 2 items.

In summary, this study examined the relationship between sleep, sleepiness, and ADHD subtypes, with emphasis on investigating the prevalence of chronic snoring among these clinical groups. The data presented were consistent with clinical perceptions and laboratory findings that sleep quality and daytime sleepiness may be abnormal in children with ADHD. Furthermore, it was demonstrated that chronic snoring and daytime sleepiness vary as a function of ADHD subtype. These findings have important relevance for both researchers and clinicians. Researchers may further the understanding of the complex relationship between sleep and ADHD by accounting for clinical subtypes in their investigations or by utilizing measures that are independently sensitive to both the hyperactive-impulsive and inattentive symptoms of the disorder. Clinically, this study confirms the importance of incorporating measures of sleep-disordered breathing and sleepiness into the assessment of ADHD.

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REFERENCES


