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# Sleep Problems and Daily Functioning in Children With ADHD: An Investigation of the Role of Impairment, ADHD Presentations, and Psychiatric Comorbidity

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## Abstract

**Objective:** Little systematic information is available regarding how sleep problems influence daytime functioning in children with ADHD, as the role of ADHD presentations and comorbidity is unclear. **Method:** In total, 397 children were assessed with the Children's Sleep Habits Questionnaire, the Weiss Functional Impairment Rating Scale, and the ADHD Rating Scale. **Results:** We found a moderate, positive correlation between sleep problems and impaired functioning in both children with ADHD and in typically developed children. ADHD presentations did not differ significantly with respect to sleep problem profile, but having a comorbid internalizing or autistic disorder lead to higher sleep problem score. **Conclusion:** Sleep problems and impaired daily functioning were more common in children with ADHD, but the overall association between sleep problems and impaired daily functioning was similar in clinical and nonclinical children. Internalizing or autistic comorbid disorders added significantly to the sleep problems. (*J. of Att. Dis.* XXXX; XX(X) XX-XX)

## Keywords

ADHD, sleep problems, daily functioning, ADHD presentations, comorbidity

## Introduction

ADHD is a neurodevelopmental disorder characterized by symptoms of inattention, hyperactivity, and impulsivity, which can be categorized into either the combined, inattentive, or hyperactive/impulsive presentation. The symptoms must be present in a range of situations, and the functional level must be inconsistent with the child's developmental stage and cause impairment in two or more settings. ADHD is estimated to occur in about 5% of children in most cultures (American Psychiatric Association [APA], 2013). Psychiatric comorbidity is reported in up to 75% of children with the disorder (Spencer, 2006).

For clinicians, symptoms of ADHD (i.e., inattention, hyperactivity, and impulsivity) are commonly the main focus during the investigation of the referred child, but for parents, impaired daily functioning in social and educational settings is more often the reason for referral. The focus on a child's difficulties at different care sectors (health care, social and educational sectors) may be in conflict with the family experienced problems and difficulties. What is really important is the daily functional level of the individual, which could be systematically evaluated in clinical consultations. In addition, the evaluation of ADHD is

generally focused on daytime symptoms. However, studies suggest that up to 70% of children with ADHD have sleep problems (Sung, Hiscock, Sciberras, & Efron, 2008). The sleep problems reported by parents and children include difficulties in falling asleep and maintaining sleep, tiredness when waking up, and daytime sleepiness (Cortese, Faraone, Konofal, & Lecendreux, 2009; Hvolby, Jorgensen, & Bilenberg, 2009; J. A. Owens, Maxim, Nobile, McGuinn, & Msall, 2000). Objective measures like actigraphy have supported the irregular pattern of sleep timing, whereas studies of the sleep structure using polysomnography have shown mixed results (Cortese et al., 2009). Differences between results from questionnaire-based studies and studies that include objective measures may arise because the two types of studies assess somewhat different sleep constructs, with questionnaires mainly addressing behavior related to sleep,

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whereas objective investigations mainly assess sleep structure and related physiological patterns during sleep (Konofal, Lecendreux, & Cortese, 2010).

In general, an adequate amount of sleep is considered integral to good daytime functioning (Galland, Tripp, & Taylor, 2010). Sleep quality and quantity have been shown to affect performance on working memory tasks in school-age children (Steenari et al., 2003), just as daily functioning and emotional regulation have been found to be impaired when sleep is inadequate (J. Owens et al., 2013; Sung et al., 2008; Yurumez & Kilic, 2013). Sleep problems in typically developed children are also strongly associated with poor quality of life, reduced daily functioning, and poorer school attendance (Sung et al., 2008). Consequently, nocturnal problems appear to deserve scrutiny when a child with ADHD is referred for an evaluation, because sleep problems appear to be an integral part of the child's impairment profile (Stores, 1996).

The ADHD presentation and the presence of comorbidity may further complicate the association between ADHD and sleep. The very few previous studies looking into presentations and sleep problems report varying results (LeBourgeois, Avis, Mixon, Olmi, & Harsh, 2004; Mayes et al., 2009; Surman et al., 2009; Yoon, Jain, & Shapiro, 2013). One study found that children with the inattentive presentation have no night-related sleep problems but report significant daytime sleepiness compared with peers, whereas the combined presentation report more night-related sleep problems compared with peers (Mayes et al., 2009). Another study found no significant difference between presentations, but the inattentive presentation had the most sleep problems (LeBourgeois et al., 2004). In adults with the inattentive presentation of ADHD, poorer sleep quality and more fatigue have been reported than in adults with the combined presentation (Yoon et al., 2013). Having comorbidity in addition to ADHD appears to add to the total reported sleep problem score (Mayes et al., 2009) and may function as a key mediating variable (Cortese et al., 2009); especially emotional disorders seem to have a high correlation with sleep problems (Dahl & Harvey, 2007), but systematic evidence in the literature is lacking. Potential differences in sleep problems for children with different presentations or comorbid profiles are important to detect because they may influence the type of assessment and intervention needed.

To summarize, the presence of sleep-related problems in children with ADHD appears to be well established (Cortese et al., 2009). Previous studies of sleep and ADHD have primarily focused on the prevalence of sleep problems in ADHD, as compared with typically developing groups or groups with other psychiatric disorders (Hvolby et al., 2009). Etiological factors such as delayed melatonin secretion (Van der Heijden, Smits, Van Someren, & Gunning, 2005) have been explored and a link to hypocretin deficiency,

as seen in narcolepsy, has been proposed (Cortese, Konofal, & Lecendreux, 2008). However, as of yet, no unequivocal conclusion has been reached regarding the relation between ADHD and sleep. We do not yet know the etiology of ADHD nor of the sleep-related problems and how the neural pathways interact or even overlap. Furthermore, sleep problems are not subjectively reported or objectively measured in all children with ADHD, so exploratory research into the different phenotypes may help detect the etiology of ADHD and sleep.

To date, little attention has been paid to the degree of impairment caused by sleep problems in children with ADHD. If the functional level is correlated with the amount of reported sleep problems, the emphasis on early intervention in treating the sleep-related problems could be essential for the child and the family. Sleep hygiene has been shown to relieve some of the sleep-related problems in a child with ADHD (Weiss, Wasdell, Bomben, Rea, & Freeman, 2006), thereby potentially avoiding some of the impairment related to poor sleep. Another matter with existing studies is the question of generalizability: Many samples include selected patients with clinical diagnoses, no comorbidity, and unclear medication status. As such, obtaining evidence from large naturalistic cohorts combining child characteristics, including presentation and comorbidity, and examining the association between sleep and clinically relevant parameters, impairment of daily functioning and ADHD symptoms are warranted to obtain knowledge about how sleep problems impact children with ADHD.

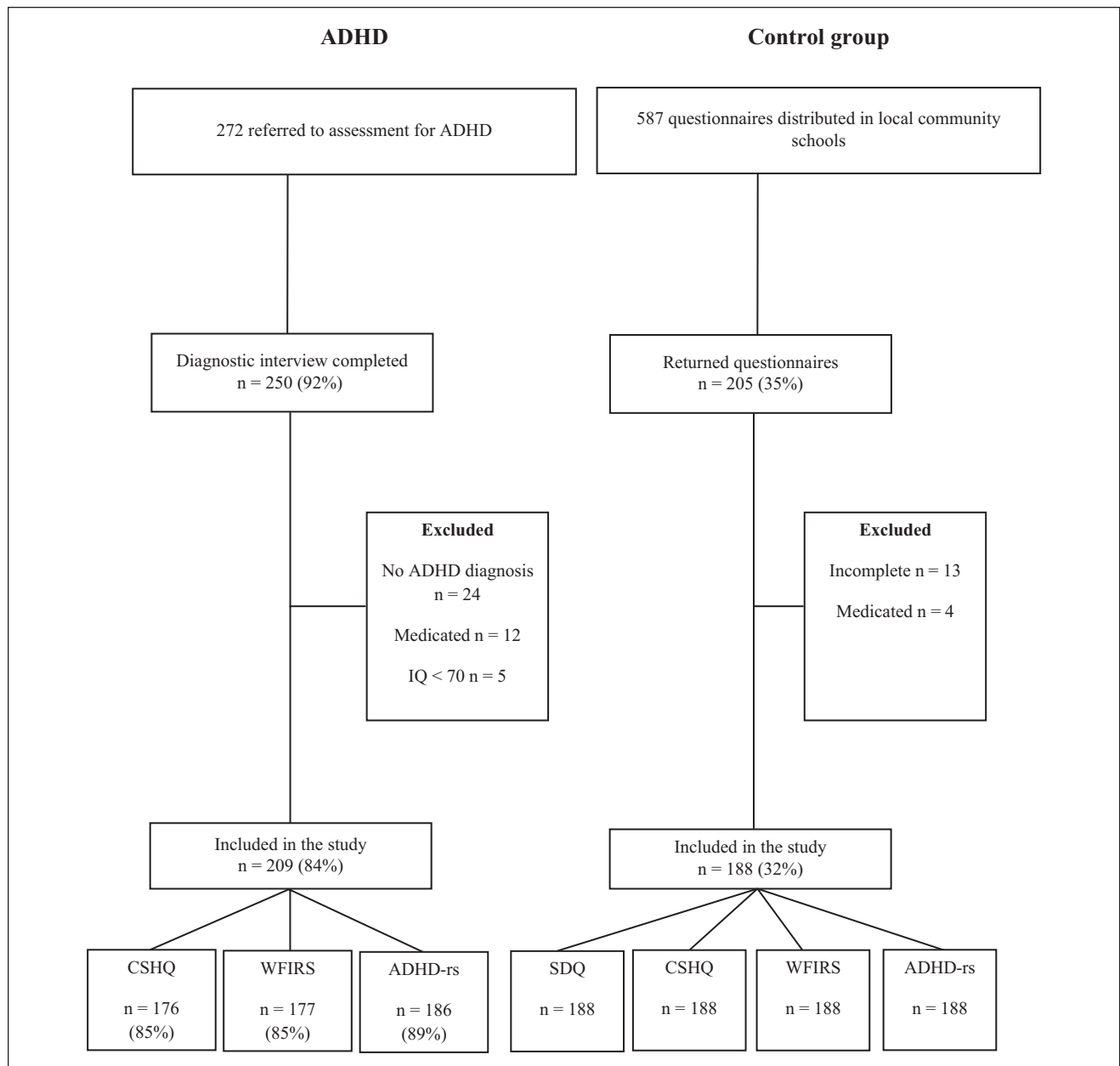
The overall purpose of the present study is to examine the association between sleep problems and impaired daily functioning in children with and without ADHD and to investigate the association between ADHD presentations and comorbidity in sleep-related problems. Specifically, we aim to (a) assess sleep problems and daily function in children with ADHD and typically developing age-matched peers and (b) investigate the associations between comorbidity and ADHD presentations with sleep and daily functioning.

We hypothesized that children with ADHD would have more sleep problems than their typically developing peers and that there would be an association between reported sleep problems and impaired daily functioning in the ADHD group. Due to the paucity of studies on ADHD presentations, comorbidity, and sleep—and previous ambiguous results—analyses in the present study involving presentation and comorbidity are exploratory.

## **Method**

### *Participants and Procedures*

The Danish Regional Ethics Committee and the Danish Data Protection Agency approved the study.



**Figure 1.** Recruitment flowchart. All questionnaires were administered before the clinical examination of referred children.

Note. CSHQ = Children's Sleep Habits Questionnaire; WFIRS = Weiss Functional Impairment Rating Scale; ADHD-RS = ADHD Rating Scale; SDQ = Strengths and Difficulties Questionnaire.

### Clinical Children

All patients consecutively referred from 1 January 2011 to the 1 January 2013 to a public child and adolescent psychiatric hospital were included in the study ( $n = 209$ ). Inclusion criteria were age 6 to 13 years and a diagnosis of ADHD. Exclusion criteria were former treatment with stimulants and IQ below 70 measured with the Wechsler Intelligence Scale for Children–Third Edition (Wechsler, 1991; Figure 1).

ADHD diagnoses were based on the Development and Well-Being Assessment (DAWBA; Goodman, Ford, Richards, Gatward, & Meltzer, 2000). The DAWBA is a standardized assessment for *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; APA, 1994) psychiatric diagnoses and integrates information from parents (structured interview) and teachers (questionnaire). The parent interview was administered by telephone, whereas the teacher questionnaire was administered via mail to the child's primary teacher. A child and adolescent

psychiatrist assessed the DAWBA, and any uncertainty about diagnoses was discussed with a second child and adolescent psychiatrist until consensus was achieved. Parents completed the following questionnaires: Children's Sleep Habits Questionnaire (CSHQ; J. A. Owens, Spirito, & McGuinn, 2000) for sleep-problems assessment, Weiss Functional Impairment Rating Scale (WFIRS; Weiss, 2011) for daily functioning and ADHD Rating Scale (ADHD-RS; Barkley, 1999) for a symptom score. All questionnaires were mailed to the parents and completed before the actual clinical investigation, so parents and interviewer were unaware of the final clinical diagnosis.

Based on the results from the DAWBA, children were grouped according to ADHD presentation and the presence of comorbidity. If more than one comorbid condition in addition to the ADHD diagnosis was present, the diagnostic groups were categorized so that the patient was present in only one category. The categories from first to last order were as follows: autism spectrum disease, internalizing disorders, externalizing disorders, and tics/Tourette syndrome. Five groups emerged: ADHD with no comorbidity, ADHD with internalizing comorbidity (depression, anxiety, obsessive compulsive disorder), ADHD with externalizing comorbidity (conduct disorder, oppositional defiant disorder), ADHD with autism, and ADHD with Tourette syndrome and tics.

### Typically Developing Children

Typically developing children were recruited from local community schools (third-sixth grade). Envelopes with information about the study and questionnaires were distributed in classrooms. In addition to the same questionnaires completed by the clinical group, the parents in the control group also completed the hyperactivity/inattention subscale from the Strengths and Difficulties Questionnaire (SDQ; Goodman, 2001). This subscale was included to examine whether any of the children in the control group were above the cutoff for hyperactivity and inattention. Children above the cutoff were not excluded from analyses, because the study aimed to include a control sample of non-referred children regardless of symptomatology. Returned questionnaires had to be complete for a child to be enrolled in the study. Controls treated with ADHD medication were excluded as well as were children with other diseases of the central nervous system (Figure 1).

### Measures

The CSHQ is a 1-week recall parent questionnaire developed as a screening instrument for children aged 4 to 12 years. Parents rate the occurrence of 33 sleep habits or sleep problems in the most recent typical week. The questionnaire provides a total score (33-99 points) and eight subscale

scores: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Waking, Parasomnia, Sleep Disordered Breathing, and Daytime Sleepiness. A total score >41 yields adequate sensitivity (0.80) and specificity (0.70) in differentiating children with and without sleep disturbances (J. A. Owens, Spirito, et al., 2000). The questionnaire was translated into Danish using traditional back-translation procedures and used with permission from the original author. In this study, the CSHQ had an acceptable internal consistency (Cronbach's  $\alpha$  range = .62-.73).

The WFIRS is developed to assess impairment in daily functioning in children with ADHD. Parents fill in the 50-item questionnaire (0-3 points). The score is divided into subdomains of possible impairment (family, school, life skills, self-concept, social activities, and risky activities). The measure has been psychometrically validated (Weiss, 2011). The scale can be scored by looking at the total score or by creating a mean score for the total score divided by the number items for each domain, omitting those rated not applicable (Weiss, 2011). The questionnaire was translated into Danish using traditional back-translation procedures and used with permission from the original author. Cronbach's alpha displayed good internal consistency (0.88-0.90).

The ADHD-RS modified by Barkley is a 26-item questionnaire including the 18 original ADHD-RS-IV items supplemented with eight conduct problem items. The total score (0-78) and three subscales: inattentive scale, hyperactive/impulsive scale, and conduct scale can all be calculated from the item scores. The questionnaire was previously translated into Danish and validated in a Danish nationwide multicenter study (Szomlajski, 2009). (Cronbach's alpha range = .82-.90.)

### Statistical Analyses

Analyses were conducted using the statistical software program Stata 13. Data were plotted for normal distribution. Because WFIRS and the ADHD-RS are developed for children with attention problems, data from the control group were not normally distributed and data were log transformed to fit assumptions. Raw scores are presented in the tables. Summary statistic, effect sizes (Cohen's  $d$ ), and linear regression models were applied. All analyses were carried out with an adjustment for age and gender. An alpha level was set at .05 in all statistical analyses.

### Results

Response rate on the DAWBA was 92%; 22 interviews were not completed due to language problems ( $n = 7$ ), refusal ( $n = 2$ ), or unavailability ( $n = 13$ ). Response rates in the clinical group to the questionnaires were 85% for the CSHQ, 85% for the WFIRS, and 89% for the ADHD-RS.



**Table 1.** Total Scores and Subscale Scores on CSHQ, WFIRS, and ADHD-RS in the Control Group and in the Patient Group.

	Controls (SD)	Patients (SD)	Difference (95% CI)	ES (95% CI)
Age	9.7 (1.5)	9.6 (1.9)		
Gender (% male)	52	79		
CSHQ				
Total score	40.6 (4.9)	47.5 (7.6)	6.8 [5.5, 8.1]*	1.1 [0.9, 1.3]
Subscales				
1. Bedtime resistance	6.9 (1.7)	7.9 (2.3)	0.9 [0.5, 1.3]*	0.5 [0.2, 0.7]
2. Sleep-onset disorder	1.4 (0.6)	1.9 (0.8)	0.5 [0.3, 0.6]*	0.7 [0.5, 0.9]
3. Sleep duration	3.5 (0.9)	4.6 (1.7)	1.1 [0.8, 1.4]*	0.8 [0.6, 1.0]
4. Sleep anxiety	4.7 (1.3)	5.7 (1.9)	1.0 [0.7, 1.4]*	0.6 [0.4, 0.8]
5. Night waking	3.5 (1.0)	3.9 (1.3)	0.4 [0.2, 0.6]*	0.3 [0.1, 0.6]
6. Parasomnias	7.8 (1.1)	8.8 (1.9)	1.1 [0.8, 1.4]*	0.7 [0.5, 0.9]
7. Sleep-disordered breathing	3.2 (0.5)	3.5 (0.9)	0.3 [0.1, 0.4]*	0.4 [0.2, 0.6]
8. Daytime sleepiness	12.0 (2.2)	14.0 (3.3)	2.0 [1.4, 2.5]*	0.7 [0.5, 0.9]
WFIRS				
Total score	0.1 (0.2)	0.8 (0.4)	0.7 [0.7, 0.8]*	2.4 [2.2, 2.7]
Subscales				
A. Family	0.2 (0.2)	1.0 (0.6)	0.8 [0.7, 0.9]*	1.6 [1.4, 1.8]
B. Learning and school	0.0 (0.1)	0.9 (0.5)	0.9 [0.8, 1.0]*	2.5 [2.2, 2.8]
C. Life skills	0.2 (0.2)	0.9 (0.6)	0.7 [0.6, 0.8]*	1.6 [1.4, 1.8]
D. Child's self-concept	0.2 (0.3)	1.0 (0.7)	0.8 [0.7, 1.0]*	1.5 [1.2, 1.7]
E. Social activities	0.1 (0.2)	0.9 (0.6)	0.8 [0.7, 0.9]*	1.9 [1.6, 2.1]
F. Risky activities	0.0 (0.1)	0.3 (0.3)	0.3 [0.2, 0.3]*	1.4 [1.1, 1.6]
ADHD-RS				
Total score	7.0 (7.1)	39.7 (14.2)	33.4 [31.0, 35.8]*	2.9 [2.6, 3.2]
Subscales				
1. Inattentive	3.3 (3.9)	16.9 (5.4)	13.5 [12.5, 14.5]*	2.8 [2.5, 3.1]
2. Hyperactive	2.3 (3.0)	14.3 (6.5)	12.0 [10.9, 13.1]*	2.4 [2.1, 2.6]
3. Conduct	1.3 (2.1)	8.0 (5.6)	7.7 [6.8, 8.6]*	1.8 [1.6, 2.1]

Note. CSHQ = Children's Sleep Habits Questionnaire; WFIRS = Weiss Functional Impairment Rating Scale; ADHD-RS = ADHD Rating Scale; SD = standard deviations; CI = confidence interval; ES = effect sizes.

\* $p < .001$ .

The overall response rate in the control group was 35%, and after exclusion 32% (revisit Figure 1). In the control group, three children (2%) were above the cutoff on the SDQ hyperactivity/inattention scale.

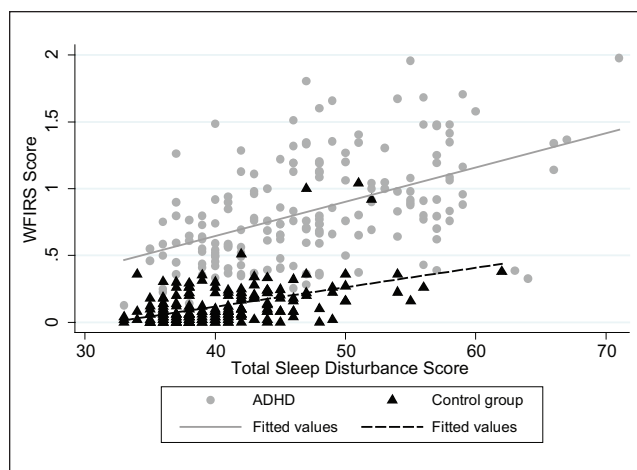
Clinical and nonclinical groups did not differ significantly with respect to age, albeit there were significantly more males in the clinical group than in the nonclinical group (79% vs. 52%, respectively; Table 1).

Children with ADHD and typically developing children obtained significantly different scores on the specific questionnaires addressing sleep, daily functioning, and ADHD symptoms. Effect sizes for the total scores on the CSHQ, WFIRS, and the ADHD-RS were large (Table 1). In general, children with ADHD had more problems than typically developing counterparts. The results were unaffected by whether the mother or the father filled in the questionnaire. The reported prevalence of sleep problems in the present study was 68% of children with ADHD (75% in children

with comorbidity vs. 59% without comorbidity) compared with 26% of the control group.

Correlating the sleep score with daily functioning (Figures 2 & 3) in patients and controls resulted in similar correlation coefficients in the two groups,  $r = .50$  [0.38, 0.60] in the ADHD group and  $r = .46$  [0.31, 0.57] in the control group. To further test whether the slopes differed between the two group correlates, we applied a logistic regression model testing for collinearity, which showed that the two slopes did not differ significantly.

Of the 209 children who had an ADHD diagnosis, 79% met criteria for the combined presentation, 18% the inattentive presentation, and 2% the hyperactive/impulsive presentation. Within the presentations of ADHD, the inattentive presentation had a lower functional impairment score and less ADHD symptomatology than the combined type. The sleep score did not differ significantly between presentations. The correlation coefficients between sleep problems



**Figure 2.** Correlation between total sleep disturbance score from the CSHQ and WFIRS in patients,  $n = 176$  (gray dots), and in controls,  $n = 188$  (black triangles).

Note. Patients: Correlation and 95% confidence interval ( $r = .50$  [0.38, 0.60]). Controls: Correlation and 95% confidence interval ( $r = .46$  [0.31, 0.57]). CSHQ = Children's Sleep Habits Questionnaire; WFIRS = Weiss Functional Impairment Rating Scale.

and daily functioning were,  $r = .57$  [0.45, 0.67], for the combined type,  $r = .95$  [0.42, 1.0], for the hyperactive/impulsive type, and  $r = .34$  [−0.01, 0.62], for the inattentive type.

Fifty-five percent had one comorbid condition and 14% two or more comorbid conditions. The comorbidities were pooled into four categories: externalizing disorders (57%), internalizing disorders (24%), autism spectrum disorders (8%), and tics and Tourette syndrome (11%; Table 2). The presence of comorbidity contributed to a higher score on all scales in children with ADHD compared with children with no comorbidity. The total sleep score increased significantly by having an autistic or an internalizing comorbid disorder compared with having externalizing, tics and Tourette, or no comorbid disorder. In the different groups of comorbidities, the correlation coefficients between sleep problems and daily functioning were,  $r = .38$  [0.17, 0.56], in the no-comorbidity group,  $r = .30$  [−0.14, 0.64], in the internalizing group,  $r = .54$  [0.32, 0.70], for the externalizing group,  $r = .95$  [0.76, 0.99] for autism, and  $r = .64$  [0.14, 0.88] in the tics/Tourette syndrome group.

## Discussion

The present study examined the association between sleep problems and impaired daily functioning in a large cross-sectional sample of consecutively clinic-referred school-age children with ADHD and nonclinical counterparts. Furthermore, the correlations of ADHD presentation and comorbidity with reported sleep problems were examined in the clinical group.

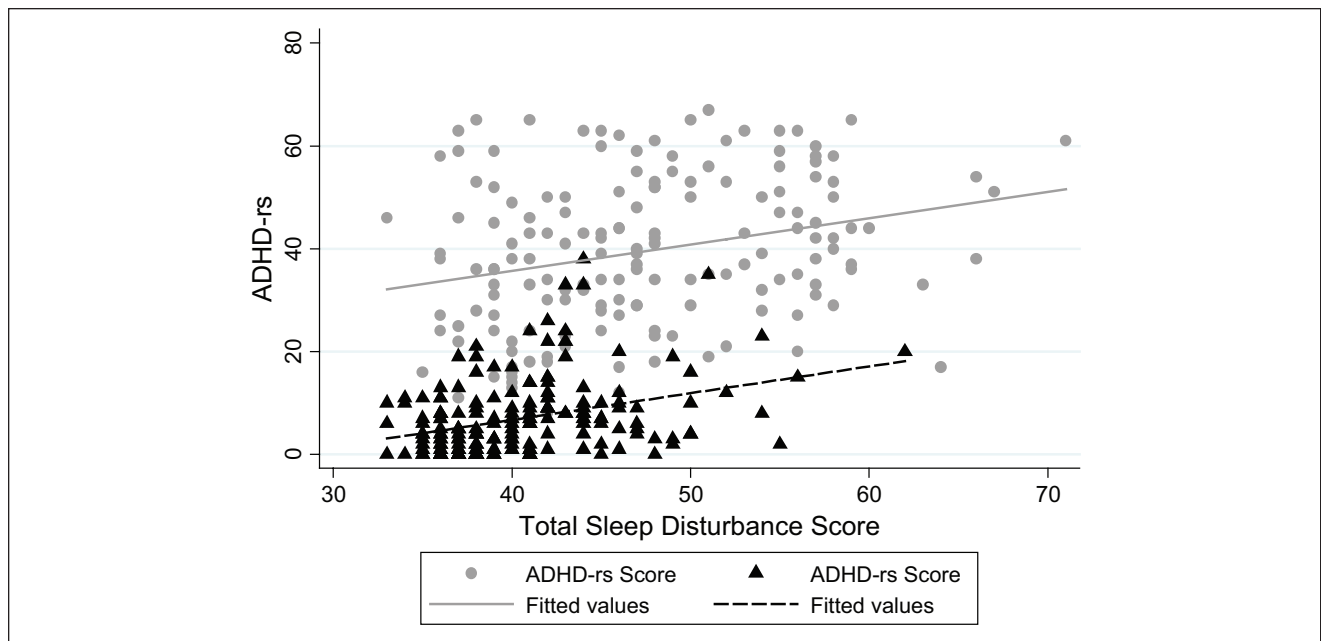
The results from the present study suggest that children with ADHD and controls differ significantly with respect to

level of sleep problems and impaired daily functioning. Overall, children with ADHD reported more sleep problems and more impaired daily functioning than did age-matched controls. The results correspond well with previous results (Yurumez & Kilic, 2013). Sleep problems were associated with impaired daily functioning in both patients with ADHD and controls. This suggests that sleep problems impair daily functioning regardless of diagnostic status. The correlation between reported sleep problems and daily functioning remained positive across presentations and comorbid groups.

By grouping children with ADHD according to *DSM-5* (5th ed.; APA, 2013) presentation or comorbid condition, a more nuanced picture emerged. We found that the inattentive presentation had more sleep problems than the combined type (although the result was not statistically significant), which is consistent with previous studies examining school-age (LeBourgeois et al., 2004) as well as adult samples (LeBourgeois et al., 2004; Yoon et al., 2013), but different from another study that included a childhood sample (Mayes et al., 2009). Both studies examining childhood populations included medicated and nonmedicated children and in the latter, sleep problems were measures based on a retrospective collection of 10 sleep items from the Pediatric Behavior Scale (Lindgren & Koepl, 1987). The varying results most likely reflect methodological differences between studies. The hyperactive/impulsive presentation showed a strong correlation between sleep problems and daily functional level; however, the number of included participants was limited ( $n = 5$ ). Even though we did not find any statistically significant difference in sleep scores within the ADHD presentations, it can be speculated whether combined ADHD and inattentive ADHD reflect different disorders of endogenous sleep and arousal regulation.

Children with ADHD and a co-occurring disorder presented higher scores on all measures, and the children with autism or internalizing disorders had statistically significantly higher scores on the CSHQ as well as on the WFIRS than did the other groups. This additive effect was expected because children with autism as well as internalizing disorders are known to have severe sleep problems (Hansen, Skirbekk, Oerbeck, Wentzel-Larsen, & Kristensen, 2014; Ivanenko & Johnson, 2008; Kirov, Kinkelbur, Banaschewski, & Rothenberger, 2007). The group with comorbid autism showed large correlation coefficients; however, the number of included participants was limited ( $n = 9$ ).

A major strength of the present study was the inclusion of consecutively clinic-referred children during a 2-year period to avoid selection bias. Only a few (22 out of 272) patients did not complete the diagnostic interview, which optimizes the generalizability. Exclusion of patients previously treated with central stimulants or with a low IQ, thereby removing potential confounders, also strengthened the design. Because we categorized presentations and comorbidities, it was possible to take a detailed look at the



**Figure 3.** Correlation between total sleep disturbance score from the CSHQ and ADHD-RS in patients,  $n = 161$  (gray dots), and in controls,  $n = 188$  (black triangles).

**Note.** **Patients:** Correlation and 95% confidence interval ( $r = .27$  [0.12, 0.41]). **Controls:** Correlation and 95% confidence interval ( $r = .35$  [0.21, 0.47]). CSHQ = Children's Sleep Habits Questionnaire; ADHD-RS = ADHD Rating Scale.

role of sleep in these groups, even though some of the groups included relatively few children. To eliminate possible information bias, questionnaires addressing sleep and impaired daily functioning were completed before the clinical examination of the referred child. Furthermore, rating scales provided valuable information about the degree to which a child's ADHD-related behaviors differ from peers of the same age and gender. Therefore, it is of utmost importance that the questionnaires possess adequate levels of reliability and validity (DuPaul, Power, McGoe, Ikeda, & Anastopoulos, 1998).

Limitations of the study include a low response rate in the control group (32%). Control-children often come from highly functional families with fewer problems than the average family, which may underestimate the true prevalence of the targeted problems. On the other hand, overestimation is also possible as likelihood to participate in studies increases if sleep problems are present. We found that 2% of the control group were above the cutoff for symptoms of ADHD on the SDQ. This number corresponds to previous epidemiologic findings regarding ADHD (Petersen, Bilenberg, Hoerder, & Gillberg, 2006; Scott et al., 2013), suggesting that the group was in fact representative. On the other hand, parents of a referred child may be more stressed and may overreport symptoms including sleep-related problems. In the present study, we were interested in the pure prevalence rate of sleep problems prior to intervention,

which is why we sent out the questionnaires before the clinical evaluation. Parents completed all questionnaires in the study and thereby only the parent's perspective is represented in the study. Future studies should include an objective measure of sleep to support the findings and to rule out primary sleep disorders.

Whether ADHD and the sleep-related problems share a common etiology remains unknown. The present study suggests a high prevalence of sleep problems among children with ADHD and a strong association between sleep problems and functional impairment. ADHD and many other neurodevelopmental disorders are heterogeneous conditions that probably arise from the additive and interactive effects of multiple heritable etiologies and environmental risk factors including sleep routines (Willcutt et al., 2010) and the endogenous regulation of sleep (Lecendreux, Konofal, Bouvard, Falissard, & Mouren-Simeoni, 2000). Future studies are needed to address why and how problems with sleep cause daily functional impairment.

We have shown that having an internalizing or autistic disorder comorbid in addition to ADHD augments the sleep score and the daily functioning score significantly. However, further objective measures of sleep within comorbid conditions are warranted.

Our results add to the current literature by drawing attention to the observation that the majority of children with ADHD have sleep problems, and that certain comorbid



**Table 2.** Total Scores on the CSHQ, the WFIRS, and the ADHD-RS, in the Control Group and in the Patient Group.

	Comorbidity				Presentations				Presentations (no comorbidity)			
	ADHD with no comorbidity (n = 94)	ADHD + internalizing comorbidity (n = 27)	ADHD + externalizing comorbidity (n = 66)	ADHD + autism (n = 9)	ADHD + tics/Tourette (n = 13)	ADHD combined (n = 166)	ADHD inattentive (n = 38)	ADHD hyp/imp (n = 5)	ADHD combined (n = 51-66)	ADHD inattentive (n = 21-26)	ADHD hyp/imp (n = 2)	
CSHQ total score (SD)	45.5 (7.0)	52.5 (6.5)**	46.8 (7.0)	54.9 (9.9)**	46.8 (6.8)	47.3 (13.9)	47.7 (8.6)	46.6 (8.2)	46 (7.2)	45.0 (6.9)	39.5 (0.7)	
WFIRS total score (SD)	0.7 (0.3)	0.9 (0.4)*	1.0 (0.4)**	1.1 (0.5)**	0.8 (0.4)	0.9 (0.4)	0.6 (0.3)**	0.8 (0.3)	0.8 (0.3)	0.5 (0.2)*	0.5 (0.1)	
ADHD-RS total score (SD)	36.1 (13.0)	43.6 (14.1)*	44.4 (14.4)**	37.9 (16.9)	39.1 (15.0)	47.4 (7.5)	28.7 (10.2)**	31.3 (9.0)	36.5 (12.6)	26.2 (9.1)**	25.5 (7.8)	
*p < .05. **p < .001, compared with no comorbidity, adjusted for age and gender.												
*p < .05. **p < .001, compared with ADHD combined type, adjusted for gender and age.												

Note. Comorbidity and presentations with and without comorbidity are displayed. Internalizing comorbidity (depression, anxiety, obsessive compulsive disorder), externalizing comorbidity (oppositional defiant disorder, conduct disorder). Hyp/imp = hyperactive/impulsive presentation; CSHQ = Children's Sleep Habits Questionnaire; WFIRS = Weiss Functional Impairment Rating Scale; ADHD-RS = ADHD Rating Scale; hyp/imp = hyperactive impulsive presentation; SD = standard deviations.

disorders have an additive effect on these problems, and that sleep is very important for daily function in all children. A thorough diagnostic procedure is warranted to assess all psychiatric diagnosis in a referred child because, as our data suggest, an autistic or internalizing disorder appears to worsen both sleep and functional level. We also speculate that the therapeutic success within a family including a higher daily functional level may depend on whether additional comorbidity or a sleep problem exists, is diagnosed, and treated.

## Conclusion

Sleep problems are more frequently reported in children with ADHD and generally related to daytime functioning in these children as well as in controls. This underlines the importance of sleep for daytime functioning in children, and that an awareness of sleep history is important in the psychiatric evaluation of children. The correlations between sleep and daily functioning show that daily functioning is especially important in the case of ADHD both with and without additional comorbidity, so not only a thorough sleep history is important but also the psychiatric evaluation must be accurate to treat adequately and help improve the daily functional level for the children and their families.

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## Authors' Note

Anne Virring has full access to all data and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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