Eur Child Adolesc Psychiatry (2011) 20:321–330
DOI 10.1007/s00787-011-0179-z

ORIGINAL CONTRIBUTION

Comparison of sleep problems in children with anxiety and attention deficit/hyperactivity disorders

Berit Hjelde Hansen · Benedicte Skirbekk · Beate Oerbeck · Jorg Richter · Hanne Kristensen

Received: 14 September 2010 / Accepted: 13 April 2011 / Published online: 1 May 2011

Abstract This cross-sectional case–control study compared sleep problems in consecutively referred children aged 7–13 years meeting DSM-IV criteria for anxiety disorder, attention deficit/hyperactivity disorder (ADHD), comorbid anxiety disorder and ADHD, and a group of control children of similar age and gender. Diagnoses were assessed with the Kiddie-SADS PL interview, parent form, and the sleep problems with a standardized sleep questionnaire, the Children's Sleep Habits Questionnaire (CSHQ), as reported by the mother. A total of 141 children were included (anxiety disorder ($n = 41$), ADHD ($n = 39$), comorbid condition ($n = 25$), controls ($n = 36$)). Children in the clinical groups had more sleep problems than controls. Children with anxiety disorders and children with comorbid condition were reported to have more sleep problems than children with ADHD alone. Night waking was associated with comorbid anxiety disorder and ADHD. Bedtime resistance was associated with anxiety disorder, while daytime sleepiness affected all clinical groups. Clinical management of children with ADHD and anxiety disorders needs to include assessment of sleep problems.

B. H. Hansen (✉) · B. Skirbekk · B. Oerbeck · J. Richter · H. Kristensen
Centre for Child and Adolescent Mental Health, Eastern and Southern Norway, Po.box 4623, Nydalen, 0405 Oslo, Norway
e-mail: berit.hjelde.hansen@r-bup.no

B. H. Hansen
Akershus University Hospital, Akershus, Norway

B. Skirbekk · H. Kristensen
Lovisenberg Diakonale Hospital, Oslo, Norway

Keywords Sleep · Anxiety disorders · ADHD · Comorbidity · Child

Introduction

Insufficient sleep is associated with behavioral, cognitive and emotional problems as well as difficulties in academic and social function [1–3], and sleep problems in childhood predict later psychopathology [4, 5]. Sleep problems are common in children referred to psychiatric services, with rates varying from 25 to 90% [6–8].

Anxiety disorders and ADHD are highly prevalent psychiatric conditions in child populations, and both are associated with sleep problems [9–11]. However, few studies have compared sleep problems between children with these diagnoses. Knowledge of the relative frequency and specific types of sleep problems in clinical populations is important for both clinical and research purposes, such as the development and implementation of efficient interventions.

With regard to anxiety disorders, studies on sleep problems in children are scarce. Prevalence rates as high as 88% have been reported, and the most common sleep problems reported were insomnia, (including bedtime resistance and delayed sleep onset), reluctance to sleep alone, nightmares and being overtired [12]. Furthermore, getting less sleep, higher occurrence of night waking, parasomnias, restless sleep and snoring have also been described [12–14]. Unfortunately, studies on sleep problems in children with anxiety disorders differ in methodological aspects such as the use of controls, use of assessment instruments, sleep variables included, control for comorbidity and inclusion of medicated children.

Far more studies have focused on the prevalence and type of sleep problems in children with ADHD. Prevalence

rates in clinical samples vary from 25 to 50%, a two- to threefold higher prevalence than in healthy controls [8]. A higher occurrence of bedtime resistance, sleep onset latency, night waking, unsettled sleep, difficulties with morning awakening and daytime sleepiness were reported in ADHD children compared with controls [15, 16].

Comorbidity and ADHD subtype influenced associations between sleep problems and ADHD. Comorbid anxiety increased total sleep problem score, with a higher occurrence of a range of sleep problem types [17, 18]. The role of comorbid oppositional defiant disorder (ODD) is not clear. Some studies have reported that sleep onset difficulties, bedtime resistance and difficulties getting up to be partly attributable to comorbid ODD [19], while others did not find this [20]. Children with the combined, but not the inattentive subtype of ADHD, were reported to have higher occurrence of overall sleep problems in some studies [17, 19]. Other studies reported no difference in overall sleep problems, but found snoring, parasomnias and circadian rhythm disorder to be related to the combined, but not the inattentive, subtype [21, 22].

Previous studies reporting on the relative frequency and type of sleep problems in children with ADHD, anxiety disorders or comorbid condition have methodological limitations, as structured interviews for diagnostic assessment or standardized sleep instruments have not been used. One study compared sleep problems in various childhood conditions including anxiety/depression and ADHD, and found no significant difference in the total number of sleep problems between children with anxiety/depression and children with ADHD. Children with anxiety/depression had more daytime sleepiness and also slept more than ADHD children [23]. Another study compared children with ADHD, mood/anxiety disorders, a combined group with mood/anxiety disorder and ADHD, and controls. No total sleep problem score was reported. Children with ADHD had more bedtime struggles and leg jerks than children with mood/anxiety disorder. Nocturnal awakenings were associated with mood/anxiety disorder. The majority of children received psychopharmacological treatment [14].

The aim of this study was to compare sleep problems in the referred children diagnosed with an anxiety disorder, ADHD, comorbid anxiety disorder and ADHD, and non-referred controls. We wanted to compare both the relative frequency and type of mother-reported sleep problems, and to answer the following questions: (1) Do the children with anxiety disorders or ADHD have higher occurrence of sleep problems than non-referred children? We hypothesized that clinical groups would have higher rates of overall sleep problems than controls. (2) Are there any differences between the clinical groups regarding occurrence of sleep problems? Assuming the prevalence of sleep problems to be higher in children with comorbid conditions, we hypothesized the comorbid condition to have the higher occurrence. (3) Are there specific types of sleep problems associated with either anxiety disorders, ADHD or anxiety disorders and ADHD? Based on previous findings we hypothesized that daytime sleepiness and night waking would be associated with anxiety disorders, bedtime resistance would be associated with ADHD, while sleep onset delay would be associated with all three clinical groups.

Finally, we wanted to explore the association of sleep problems with anxiety disorders or ADHD, controlling for comorbid conditions including ODD/conduct disorder (CD), and ADHD subtypes.

Methods

Sample

A total of 141 children participated: 105 children consecutively referred to two psychiatric outpatient clinics in eastern Norway, one in the capital of Oslo and one in the neighbor city of Lillestrom. Controls were recruited from nearby schools. The participants were classified into one of four groups:

- children with anxiety disorder, no ADHD, $n = 41$ (ANX);
- children with ADHD, but no lifetime threshold or subthreshold anxiety disorder, $n = 39$ (ADHD);
- children with both anxiety disorder and ADHD, $n = 25$, (ANX + ADHD);
- non-referred children with no anxiety disorder or ADHD, $n = 36$ (CTRL).

All children were medication free and did not receive any treatment for their sleep problems at the time of assessment. Table 1 shows demographics and details on comorbidity.

The types of anxiety disorders in the ANX and ANX + ADHD groups ($n = 66$) were: separation anxiety disorder, 27 (41.0%); specific phobia, 20 (30.3%); social anxiety disorder, 19 (28.8%); generalized anxiety disorder, 8 (12.1%); agoraphobia, 3 (4.5%); panic disorder, 2 (3.0%) and obsessive compulsive disorder (OCD), 14 (21.2%).

The ADHD subtypes in the ADHD and ANX + ADHD groups ($n = 64$) were:

ADHD predominantly inattentive type (ADHD IA): $n = 29$ (45.3%); ADHD combined type (ADHD C): $n = 32$ (50.0%); and ADHD hyperactive/impulsive type (ADHD HI): $n = 3$ (4.7%). The distribution of ADHD subtypes did not differ significantly between the ADHD and the ANX + ADHD groups ($\chi^2 = 1.41$, $df = 2$,

Table 1 Descriptive characteristics and details on comorbidity of children with anxiety disorder (ANX), ADHD, anxiety disorder and ADHD (ANX + ADHD) and non-referred controls (CTRL)

	ANX ($n = 41$)	ADHD ($n = 39$)	ANX + ADHD ($n = 25$)	CTRL ($n = 36$)	p
Age mean (SD)	10.9 (2.0)	9.8 (1.6)	10.1 (1.9)	10.7 (2.3)	0.062[a]
Gender, *n* (%)					
Girls	14 (34.1)	9 (23.1)	13 (52.0)	15 (41.7)	0.104[b]
Parent education, *n* (%)					
Mother ($n = 141$) >12 years	20 (48.8)	26 (66.7)	12 (48.0)	21 (58.3)	
≤12 years	21 (51.2)	13 (33.3)	13 (52.0)	15 (41.7)	0.334[b]
Father (n = 133) >12 years	13 (36.1)	19 (50.0)	9 (37.5)	21 (60.0)	
≤12 years	23 (63.9)	19 (50.0)	15 (62.5)	14 (40.0)	0.165[b]
Family structure, *n* (%)					
Living with both biological parents	25 (61.0)	20 (51.3)	14 (56.0)	26 (72.2)	
Other	16 (39.0)	19 (48.7)	11 (44.0)	10 (27.8)	0.300[b]
CGAS					
Mean (range)	51.3 (40–65)	52.6 (41–63)	49.9 (41–60)	89.0 (72–97)	<0.001[a]*
Comorbidity, *n* (%)					
Affective disorders	5 (12.2)	4 (10.3)	2 (8.0)	0	0.923[c]
ODD/CD	6 (14.6)	11 (28.2)	7 (28.0)	0	0.280[b]
Enuresis/encopresis	3 (7.3)	7 (17.9)	2 (8.0)	0	0.361[c]
Tics/Tourette's disorder	7 (17.1)	9 (23.1)	5 (20.0)	1 (2.8)	0.823[b]

* Clinical groups different from controls

[a] ANOVA

[b] Chi-square

[c] Exact test

Fisher's exact $p = 0.576$). Children with ADHD C and ADHD HI subtype were analyzed together, due to the small number of children with ADHD HI subtype.

Procedure

Parents of children aged 7–13 years consecutively referred to the outpatient clinics between September 2007 and February 2009 were interviewed with the Kiddie-SADS PL. Families were asked to participate if the child's symptoms fulfilled criteria for any anxiety disorder or ADHD or comorbid condition, provided none of the exclusion criteria applied.

The parents of 421 children were interviewed, and 407 gave consent for the information from the interview to be used. Of these, 271 (66.6%) described symptoms fulfilling criteria for either anxiety disorder, ADHD or both anxiety disorder and ADHD. A total of 84 (31.0%) children were excluded from participation for the following reasons: met criteria for Asperger's disorder ($n = 12$), biological mother not available/did not speak Norwegian ($n = 35$), IQ < 70 ($n = 9$, of these, two children were first included but later excluded based on results of the Wechsler Abbreviated Scale of Intelligence, WASI), had known neurological disease ($n = 4$, information from parents and referral papers), given medication for ADHD ($n = 16$), had ADHD and subthreshold or lifetime anxiety disorder ($n = 8$). Of the 187 eligible families, 107 gave written consent. Two children were later excluded due to missing questionnaires, leaving a total of 105 (56.1%).

The group of eligible children included did not differ from eligible children not included in mean age, mean score on the Children's Global Assessment Scale (CGAS), gender ratio, any anxiety disorder, ADHD, comorbid anxiety and ADHD, comorbid affective disorder, comorbid ODD/CD, comorbid enuresis/encopresis or comorbid tics/Tourette's disorder.

Assessments were conducted at one of the two outpatient clinics. The mother completed the questionnaires while the child was tested in an adjacent room. WASI [24] was used to establish the IQ level. A letter was sent to the child's main teacher with questionnaires on behavioral and emotional problems.

To increase the validity of ADHD subtyping, a combination of parent and teacher information was used. A symptom was scored as present if either a score of 3 (definite) in the Kiddie-SADS PL or 3 (very often) in the

teacher version of the Disruptive Behavior Rating Scale was given.

A total of 36 non-referred children were recruited from schools in the same catchment area and underwent the same assessments and diagnostic procedures as the clinical groups. Exclusion criteria were the presence of any anxiety disorder or ADHD.

The study was approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate. The study was performed in accordance with the ethical standards of the Declaration of Helsinki.

Instruments

The Kiddie-SADS PL is a semi-structured interview that provides DSM-IV Axis I child psychiatric (present and lifetime) diagnoses [25]. Interrater reliability in terms of kappa was 0.88 for any anxiety disorder and 0.90 for ADHD, based on recorded audiotapes from 39 randomly selected interviews. Whenever there was any doubt on the diagnostic status after the interview, consensus was obtained after discussion in the research group.

The CGAS represents an assessment of the child's overall severity of disturbance with scores ranging from 1 (lowest functioning) to 100 (excellent functioning) [26].

The Disruptive Behavior Rating Scale, Teacher Form (ADHD items) contains the 18 items corresponding to the DSM-IV symptoms of ADHD, rated on a four-point scale (0 = never, 1 = sometimes, 2 = often and 3 = very often) [27]. High internal reliability values have been demonstrated [28]. In our material, internal reliability was 0.94 and 0.92 for the inattentive and the hyperactive/impulsive subscales, respectively.

The CSHQ is a 1-week recall parental questionnaire developed as a screening instrument for children aged 4–12 years. Parents rate the occurrence of 33 sleep habits or sleep problems as occurring "usually" (5–7 times/week), "sometimes" (2–4 times/week) or "rarely" (0–1 times/week) in the most recent typical week. In addition, parents are asked to give information on bedtime schedules and estimated nightly sleep time. The questionnaire provides a total score and eight subscale scores: Bedtime Resistance, Sleep Onset Delay, Sleep Duration, Sleep Anxiety, Night Wakings, Parasomnias, Sleep Disordered Breathing and Daytime Sleepiness. The first five subscales reflect symptoms associated with common dyssomnias of childhood, while the Parasomnia and Sleep Disordered Breathing subscales represent separate sleep disorders. The subscale of Daytime Sleepiness does not map onto specific sleep disorder symptoms, but is considered the daytime consequence of disordered sleep. The higher the score, the more do sleep problems occur. Acceptable test–retest reliability and validity have been reported. A total score above 41 yielded adequate sensitivity (0.80) and specificity (0.72) in differentiating between children with and without clinical sleep disturbances [29].

The total score and the subscales of Bedtime Resistance, Sleep Duration, Sleep Anxiety and Daytime Sleepiness showed good reliability, while the Night Wakings and Parasomnias subscales had moderate reliability and the Sleep Disordered Breathing subscale had low reliability (Table 2). The questionnaire was translated into Norwegian

Table 2 The child sleep habits questionnaire, subscale descriptions

	No. of items	Cronbach's α	Description
Bedtime resistance	6	0.77	The child does not go to bed at the same time, falls asleep in another's bed, needs parents in room to sleep, struggles at bedtime, afraid of sleeping alone
Sleep onset delay	1		Defined as 20 min or more before falling asleep
Sleep duration	3	0.79	The child sleeps too little, not the right amount or not the same amount each day
Sleep anxiety	4	0.74	The child needs parents in the room to sleep, afraid of sleeping alone or in the dark, trouble sleeping away from home
Night wakings	3	0.68	The child moves to someone else's bed during the night, frequency in night waking
Parasomnias	7	0.58	Frequency in bed wetting, sleep talking, restless sleep, and moving a lot, sleep walking, bruxism, awakens screaming, awakens alarmed by scary dream
Sleep disordered breathing	3	0.26	Frequency of snoring, sleep apnea, snorting/gasping during sleep
Daytime sleepiness	8	0.77	The child wakes up by self or with help from others, is in a negative mood on awakening, has difficulties getting up in the morning, takes a long time to be alert, seems tired, is very tired or falls asleep when watching TV or riding in a car. (The last two questions are scored on a 0–2 scale)

by the University of Bergen and has been used with permission from the original author.

Statistics

The Statistical Package for Social Sciences for Windows (SPSS) Version 15.0 was used for all data analyses. Chi-square and Fisher's exact tests were used to examine differences between groups for categorical data. For continuous data, independent sample *t* tests, one-way ANOVA with post hoc comparison (Bonferroni) or non- parametric test (Kruskal–Wallis with post hoc Mann–Whitney *U* tests and Bonferroni correction) were conducted. Bonferroni corrections were made for post hoc analysis comparing between-group differences. Effect sizes for group differences were estimated by dividing the *z*-score by $\sqrt{N}$. Statistical significance was set at $p < 0.05$. Associations between the total CSHQ score, demographic characteristics and comorbidity were explored using simple linear regressions, and a hierarchical linear regression analysis of the effects of significant associations, age and belonging to one of the patient groups was then calculated.

Three questionnaires had a total of five missing values. They were replaced by the median score of the corresponding subscale. Information on estimated sleep time was missing in 11 questionnaires. Thus, analysis on estimated sleep time was completed for 130 children.

Results

Total sleep problems in clinical groups

Table 3 shows the median total CSHQ and subscale scores in the three clinical groups (ANX, ADHD, ANX + ADHD) and non-referred controls (CTRL), and between-group differences with effect sizes.

All clinical groups had significantly higher total CSHQ score than non-referred controls, with high effect size for the difference between the ANX and CTRL, and the ANX + ADHD and CTRL. Children with an anxiety disorder (ANX and ANX + ADHD) had the highest total CSHQ score, while children with ADHD without comorbid anxiety disorder had significantly higher scores than controls, but significantly lower scores than both the ANX and ANX + ADHD groups. No significant difference in the total CSHQ score was found between the ANX and ANX + ADHD groups.

To avoid overlap between anxiety symptoms and sleep problems, we omitted eight items corresponding to symptoms of either separation anxiety or specific phobia, and reran the analysis with this new total score. The difference in total score between the groups was still significant ($H = 38.82$, $df = 3$, $p = 0.001$). Post hoc analysis revealed significant differences between each clinical group and the control group (ANX: $U = 208.50$, $z = -5.42$, $p < 0.001$; ADHD: $U = 386.00$, $z = -3.36$, $p = 0.001$; ANX + ADHD: $U = 121.00$, $z = -4.84$, $p < 0.001$), and between the ANX + ADHD and ADHD groups ($U = 290.00$, $z = -2.72$, $p = 0.006$), but not between the ANX and ADHD groups.

There were significantly more children with Social Anxiety Disorder in the ANX group compared to the ANX + ADHD group (ANX: $n = 16$, ANX + ADHD: $n = 3$, $\chi^2 = 5.53$, $p = 0.019$), but no other significant difference in distribution of anxiety disorders. However, in the ANX and ANX + ADHD groups combined, the total sleep problem score or subscale scores did not differ between children with and children without Social Anxiety Disorder.

Children with anxiety disorders (ANX and ANX + ADHD) were more likely to have total sleep problem scores in a clinical range (total CSHQ score above 41) than both ADHD alone (ANX and ANX + ADHD ($n = 54$, 81.8%), ADHD ($n = 21$, 53.8%), $\chi^2 = 9.40$, $df = 1$, OR = 3.86, $p = 0.002$) and the controls (ANX and ANX + ADHD ($n = 54$, 81.8%), CTRL ($n = 9$, 25.0%), $\chi^2 = 31.84$, $df = 1$, OR = 13.50, $p < 0.001$), while children with ADHD were more likely than controls to score in a clinical range (ADHD ($n = 21$, 53.8%, CTRL ($n = 9$, 25.0%), $\chi^2 = 6.49$, $df = 1$, OR = 3.50, $p = 0.011$). No significant difference was found between the ANX and the ANX + ADHD groups.

Types of sleep problems in clinical groups

The Daytime Sleepiness subscale yielded higher scores for any clinical group than for controls, without any significant difference between the clinical groups. The effect sizes for the ANX and the ANX + ADHD groups compared to controls were both high (Table 3).

There were five significant differences between clinical groups relating to various types of sleep problems: more Bedtime Resistance was reported for ANX children than ADHD children, ANX and ANX + ADHD children showed more Sleep Anxiety than ADHD children, and ANX + ADHD children had more Night Wakings than ADHD or ANX children. The effect size for ANX + ADHD compared to ADHD on the Sleep Anxiety subscale was high and the other between-group differences were of moderate effect size. Other than for Night Wakings, there were no significant differences on subscale level between the ANX and the ANX + ADHD groups (Table 3).

The sleep problem Sleep Onset Delay was present in a higher proportion in children with ANX or ANX + ADHD compared to controls (ANX = 26, CTRL = 8, $\chi^2 = 13.19$,

Table 3 The Children's Sleep Habit Questionnaire (CSHQ): median, range and significant between-group comparisons of total CSHQ score on seven of eight subscales

	ANX ($n = 41$)	ADHD ($n = 39$)	ANX + ADHD ($n = 25$)	CTRL ($n = 36$)	H^a	Post hoc[b]	p	Effect size
Total CSHQ score	47 (38–71)	42 (32–61)	53 (34–72)	37 (32–48)	49.64	**ANX > CTRL**	**<0.001**	**0.67**
						ADHD > CTRL	**<0.001**	**0.41**
						ANX + ADHD > CTRL	**<0.001**	**0.66**
						ANX > ADHD	**0.001**	**0.37**
						ANX + ADHD > ADHD	**<0.001**	**0.45**
Bedtime resistance	8 (6–17)	6 (6–12)	9 (6–15)	6 (6–14)	20.43	**ANX > CTRL**	**<0.001**	**0.43**
						ANX + ADHD > CTRL	**0.003**	**0.38**
						ANX > ADHD	**0.002**	**0.35**
						ANX + ADHD > ADHD	0.009	0.33
Sleep duration	4 (3–8)	3 (3–8)	5 (3–8)	3 (3–7)	17.23	**ANX > CTRL**	**<0.001**	**0.40**
						ANX + ADHD > CTRL	**0.001**	**0.42**
						ANX > ADHD	0.028	0.24
						ANX + ADHD > ADHD	0.026	0.28
Sleep anxiety	6 (4–12)	5 (4–11)	7 (4–11)	4 (4–7)	43.08	**ANX > CTRL**	**<0.001**	**0.55**
						ADHD > CTRL	0.020	0.27
						ANX + ADHD > CTRL	**<0.001**	**0.70**
						ANX > ADHD	**0.001**	**0.38**
						ANX + ADHD > ADHD	**<0.001**	**0.55**
Night wakings	3 (3–7)	3 (3–7)	4 (3–8)	3 (3–5)	18.54	**ANX + ADHD > CTRL**	**<0.001**	**0.52**
						ANX + ADHD > ADHD	**0.006**	**0.34**
						ANX + ADHD > ANX	**0.003**	**0.36**
Parasomnias	9 (7–12)	8 (7–12)	10 (7–16)	7 (7–13)	17.85	**ANX > CTRL**	**0.003**	**0.34**
						ADHD > CTRL	0.033	0.25
						ANX + ADHD > CTRL	**<0.001**	**0.49**
						ANX + ADHD > ADHD	0.018	0.30
Sleep disordered breathing	3 (3–5)	3 (3–6)	3 (3–5)	3 (3–4)	9.67	**ADHD > CTRL**	**0.005**	**0.25**
						ANX + ADHD > CTRL	0.033	0.27
Daytime sleepiness	14 (8–21)	12 (6–20)	14 (8–20)	9 (6–17)	31.70	**ANX > CTRL**	**<0.001**	**0.57**
						ADHD > CTRL	**0.003**	**0.35**
						ANX + ADHD > CTRL	**<0.001**	**0.55**
						ANX > ADHD	0.019	0.26
						ANX + ADHD > ADHD	0.032	0.27

Significant differences after Bonferroni correction marked in bold

[a] Kruskal Wallis test, all with $df = 3$; $p \leq 0.001$

[b] Mann-Whitney U test with Bonferroni correction

$df = 1$, OR = 6.07, $p < 0.001$; ANX + ADHD = 15, CTRL = 8, $\chi^2 = 8.97$, OR = 5.25, $df = 1$, $p = 0.003$), but *not* compared to children with ADHD (ADHD = 17, χ^2 vs ANX = 3.16, $df = 1$, $p = 0.075$; χ^2 vs ANX + ADHD = 1.64, $df = 1$, $p = 0.200$). More children with ADHD than controls had Sleep Onset Delay; the difference bordered on significance and did not exist after Bonferroni correction (ADHD = 17, CTRL = 8, $\chi^2 = 3.85$, OR = 2.70, $p = 0.050$). The Sleep Onset Delay subscale contains only one item, so this variable was dichotomized by defining sleep onset delay (not falling asleep within 20 min) as present if scored as occurring "sometimes" or "usually".

The ADHD group scored significantly higher than controls on the subscale Sleep Disordered Breathing, in contrast to the other clinical groups (Table 3). Because this subscale had the lowest internal consistency, we analyzed at the item level: snoring was reported to occur sometimes or often in 12 (30.8%) children with ADHD, five (12.2%) in the ANX group, 4 (16.0%) in the ANX + ADHD group and 2 (5.6%) in the control group. Only the difference

between the ADHD group and the control group was significant ($\chi^2 = 7.84$, $df = 1$, OR = 7.56, $p = 0.005$).

The estimated nightly sleep time did not differ significantly between children in clinical groups and controls, or between clinical groups ($F = 1.86$, $df = 3, 127$, $p = 0.139$).

Comorbidity, ADHD subtypes and sleep problems

The total CSHQ score was significantly associated with comorbid ODD/CD, but not with the presence of a comorbid affective disorder, enuresis/encopresis or tics/Tourette's disorder, age, gender, parent educational level or family structure. In a hierarchical linear regression model with total CSHQ score as the dependant variable, belonging to either one of the clinical groups (ANX, ADHD or ANX + ADHD) explained a significant amount of variance in CSHQ. The presence of ODD/CD did not explain any significant additional variance in the CSHQ total score when the clinical group variable was controlled for (Table 4).

Children with ADHD and comorbid ODD/CD did not significantly differ from children with ADHD without comorbid ODD/CD on total CSHQ score, any subscale score or estimated nightly sleep time. However, the number of children with ADHD and comorbid ODD/CD was low ($n = 18$, 28.1% of 64 children with ADHD). Children with the ADHD C/HI subtypes combined and ADHD IA subtype did not differ significantly on total CSHQ score or any subscale score.

Discussion

In this cross-sectional study, we compared the sleep problems in children with anxiety disorders, ADHD, comorbid anxiety disorder and ADHD and controls. All children were medication free and we used standardized instruments for clinical diagnoses and sleep assessment. It thus addresses some of the limitations of previous studies on sleep problems in children with anxiety disorders, and adds to the knowledge of sleep problems in children with ADHD.

As hypothesized in research question number one, children in the three clinical groups had a higher occurrence of sleep problems than controls. Our hypothesis in research question number two of more sleep problems in children with the comorbid condition than either ADHD or anxiety disorder alone, was supported for ADHD, but not for anxiety disorder. This finding suggests a strong and specific association between sleep problems and anxiety disorders. A strong association of sleep problems with anxiety disorders is consistent with a theory of closely interconnecting systems regulating sleep and affect [30]. Specificity of sleep problems to anxiety disorders was previously demonstrated in an epidemiological longitudinal study, which demonstrated childhood sleep problems to predict anxiety disorder, but not depression, in adults [4].

Sleep problems were the rule rather than the exception in children with anxiety disorders, with as many as 81.8% showing sleep problems in a possible clinical range. The high total sleep problem score was not explained by comorbidity with other psychiatric conditions, or by an inflation of the association between anxiety disorders and sleep problems due to overlapping symptoms. Our findings are in line with previous reports of high occurrences of sleep problems in this population [10, 13] and underscore the importance of addressing sleep problems when treating children with anxiety disorders.

Regarding research question number three, differences in types of sleep problems between clinical groups, our hypotheses were not confirmed. Daytime sleepiness, which is considered the daytime consequence of disrupted sleep [8], occurred more frequently in all clinical groups than in controls, with no significant differences between clinical groups, while we initially hypothesized this to be associated with anxiety disorders. Though children with ADHD did not differ in daytime sleepiness from children with anxiety disorders, the sum of their reported sleep problems was lower. This may indicate that some types of sleep problems associated with ADHD are not captured properly by a parent questionnaire such as the CSHQ. Variability in sleep onset latency, sleep fragmentation due to restless legs, periodic limb movement disorder or sleep disordered breathing could be such sleep problems [8, 31, 32]. Another explanation may be that in some children with ADHD, the reported daytime sleepiness is an expression of neurophysiological underarousal, rather than a consequence of insufficient sleep [17]. One could also speculate that

Table 4 Hierarchical regression of age (step 1), occurrence of anxiety disorder (ANX), ADHD or comorbid anxiety disorder and ADHD (ANX + ADHD) (step 2), and oppositional defiant disorder/conduct disorder (ODD/CD) (step 3) on total CSHQ score

Step and independent variables	Standardized		
	β	t	P
1 Age	0.03	0.37	0.715
2 Age	0.08	1.00	0.321
ANX, ADHD or ANX + ADHD	0.46	6.10	<0.001
3 Age	0.09	1.17	0.243
ANX, ADHD or ANX + ADHD	0.44	5.60	<0.001
Comorbid ODD	0.10	1.20	0.234

Adj. R^2 for step 1 = −0.01, ΔR^2 for step 1 <0.01

Adj. R^2 for step 2 = 0.20, ΔR^2 for step 2 = 0.21

Adj. R^2 for step 3 = 0.20, ΔR^2 for step 3 = 0.01

children with ADHD may be more vulnerable to the effects of insufficient sleep. Individual vulnerability to the effects of sleep deprivation has been demonstrated, and in healthy adults, baseline executive functions moderated the effect of sleep deprivation [33, 34].

Bedtime resistance was related to anxiety disorders, but not as hypothesized to ADHD. Frequent occurrence of bedtime resistance has been reported in both ADHD and anxiety disorders [11, 13]. Our result contrasts with that previously reported in a comparison of this sleep problem between children with anxiety disorder and children with ADHD. Methodological issues such as the inclusion of children taking medication, and the use of other diagnostic tools and sleep instruments in the other study may account for this discrepancy [14].

Children with comorbid anxiety disorder and ADHD had a higher frequency of night waking than children with ADHD or anxiety disorder alone. We initially hypothesized this to be associated with anxiety disorders, according to a previous report [14]. A direct comparison between this study and ours is difficult, however, due to methodological issues. One reason why this sleep problem occurs more frequently in children with comorbid anxiety disorder and ADHD may be that these children experience sleep fragmentation due to sleep movement disorders or sleep disordered breathing associated with their ADHD [16, 31], while the high arousal associated with anxiety disorder [13] increases the inclination to actually wake.

Sleep onset delays were reported in children with an anxiety diagnosis, compared to controls. This is in line with one study that has reported separately on children with anxiety disorders [13]. Children with ADHD without comorbid anxiety were not reported to have significantly more frequent sleep onset delay than controls, in contrast to our initial hypothesis, and to previous studies [11, 35]. However, one study, after adjusting for comorbid anxiety disorder, did not find higher occurrence of sleep onset delay associated with ADHD [18]. The lack of significant difference between children with ADHD and controls may reflect a weakness of questionnaires in finding variability in sleep onset. We did not find any significant difference between the clinical groups, which is in accordance with an actigraphy study comparing sleep initiation in children with ADHD and children with anxiety disorders [35]. In our study, comorbid anxiety disorder did not increase the liability of having sleep onset delay in children with ADHD.

In children with ADHD, comorbid anxiety disorder influenced the occurrence of total sleep problems, while comorbid ODD/CD or ADHD subtype did not. Comorbid anxiety disorder was associated with higher total score and higher occurrence of sleep anxiety and night waking, while ADHD subtype or comorbid ODD/CD did not significantly influence the total sleep problem score or any subscale score. Some researchers hold the view that sleep problems in children with ADHD are partly explained by comorbid ODD/CD [36, 37], but results diverge [17, 20]. Inconsistent findings have also been reported with regard to ADHD subtypes and sleep problems [17, 22] In accordance with our findings, future studies exploring the influence of comorbid ODD/CD or ADHD subtype on sleep problems in children with ADHD will need to control for comorbid anxiety disorder.

Limitations

Due to the cross-sectional nature of the study, no conclusion regarding the direction of influence between clinical disorder and sleep problems can be drawn. The sample sizes were small; thus, clinically important between-group differences regarding sleep problem type could be missed.

Only mother report, not self-report or sleep diary, was used to assess sleep problems, and the questionnaire assessed only the most recent typical week. Parents of children referred to psychiatric treatment may be more sensitive to their child's sleep problems than parents of non-referred children, resulting in biased reporting of symptoms [3, 11, 13]. Including self-report or sleep diary could reduce a reporter or recall bias, and a sleep diary could give valuable information on day to day variation and more accurate figures on sleep onset delay [38].

Diagnoses were based solely on parent interview, and this could lead to under-reporting of anxiety symptoms in children with ADHD as well as ADHD symptoms in children with anxiety disorders. However, such misclassification resulting in more mixed groups would probably lead to a reduction in the observed differences between the groups. Children recruited as controls may be skewed toward higher functioning and fewer sleep problems; thus, the difference in sleep problems between clinical groups and controls might be inflated due to selection bias. However, our prevalence rates of sleep problems in the control group matches those of previous population-based studies using the same instrument, validating our findings [29, 39, 40].

Conclusion

The prevalence of sleep problems is high in referred children with anxiety disorders. Children with ADHD have a higher prevalence of sleep problems than non-referred children, especially if comorbid anxiety disorder is present**.** Clinical management of children with ADHD and anxiety disorders should include assessment of sleep problems. In children with ADHD and bedtime resistance, careful assessment of comorbid anxiety disorder is recommended.

Acknowledgments The research was funded by the Norwegian Research Council.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Sadeh A, Gruber R, Raviv A (2002) Sleep, neurobehavioral functioning, and behavior problems in school-age children. Child Dev 73(2):405–417
2. Ravid S, Afek I, Suraiya S, Shahar E, Pillar G (2009) Sleep disturbances are associated with reduced school achievements in first-grade pupils. Dev Neuropsychol 34(5):574–587
3. Paavonen EJ, Solantaus TMD, Almqvist FMD, Aronen ETM (2003) Four-year follow-up study of sleep and psychiatric symptoms in preadolescents: relationship of persistent and temporary sleep problems to psychiatric symptoms. J Dev Behav Pediatr 24(5):307–314
4. Gregory AM, Caspi A, Eley TC, Moffitt TE, Oconnor TG, Poulton R (2005) Prospective longitudinal associations between persistent sleep problems in childhood and anxiety and depression disorders in adulthood. J Abnorm Child Psychol 33(2):157–163
5. Gregory AM, Van der Ende J, Willis TA, Verhulst FC (2008) Parent-reported sleep problems during development and self-reported anxiety/depression, attention problems, and aggressive behavior later in life. Arch Pediatr Adolesc Med 162(4):330–335
6. Alfano CA, Gamble AL (2009) The role of sleep in childhood psychiatric disorders. Child Youth Care Forum 38(6):327–340
7. Ivanenko A, Crabtree VM, Gozal D (2004) Sleep in children with psychiatric disorders. Pediatr Clin North Am 51(1):51–68
8. Owens JA (2005) The ADHD and sleep conundrum: a review. J Dev Behav Pediatr 26(4):312–322
9. Tsai MH, Huang YS (2010) Attention-deficit/hyperactivity disorder and sleep disorders in children. Med Clin North Am 94(3):615–632
10. Alfano CA, Beidel DC, Turner SM, Lewin DS (2006) Preliminary evidence for sleep complaints among children referred for anxiety. Sleep Med 7(6):467–473
11. Owens JA, Maxim R, Nobile C, McGuinn M, Msall M (2000) Parental and self-report of sleep in children with attention-deficit/hyperactivity disorder. Arch Pediatr Adolesc Med 154(6):549–555
12. Alfano CA, Ginsburg GS, Kingery JN (2007) Sleep-related problems among children and adolescents with anxiety disorders. J Am Acad Child Adolesc Psychiatry 46(2):224–232
13. Alfano CA, Pina AA, Zerr AA, Villalta IK (2010) Pre-sleep arousal and sleep problems of anxiety-disordered youth. Child Psychiatry Hum Dev 41(2):156–167
14. Ivanenko A, Crabtree VM, Obrien LM, Gozal D (2006) Sleep complaints and psychiatric symptoms in children evaluated at a pediatric mental health clinic. J Clin Sleep Med 2(1):42–48
15. Corkum P, Tannock R, Moldofsky H, Hogg-Johnson S, Humphries T (2001) Actigraphy and parental ratings of sleep in children with attention-deficit/hyperactivity disorder (ADHD). Sleep 24(3):303–312
16. Cortese S, Faraone SV, Konofal E, Lecendreux M (2009) Sleep in children with attention-deficit/hyperactivity disorder: meta-analysis of subjective and objective studies. J Am Acad Child Adolesc Psychiatry 48(9):894–908
17. Mayes SD, Calhoun SL, Bixler EO, Vgontzas AN, Mahr F, Hillwig-Garcia J, Elamir B, Edhere-Ekezie L, Parvin M (2009) ADHD subtypes and comorbid anxiety, depression, and oppositional-defiant disorder: differences in sleep problems. J Pediatr Psychol 34(3):328–337
18. Mick E, Biederman J, Jetton J, Faraone SV (2000) Sleep disturbances associated with attention deficit hyperactivity disorder: the impact of psychiatric comorbidity and pharmacotherapy. J Child Adolesc Psychopharmacol 10(3):223–231
19. Corkum P, Moldofsky H, Hogg-Johnson S, Humphries T, Tannock R (1999) Sleep problems in children with attention-deficit/hyperactivity disorder: impact of subtype, comorbidity, and stimulant medication. J Am Acad Child Adolesc Psychiatry 38(10):1285–1293
20. Hvolby A, Jorgensen J, Bilenberg N (2009) Parental rating of sleep in children with attention deficit/hyperactivity disorder. Eur Child Adolesc Psychiatry 18(7):429–438
21. Chiang HL, Gau SS, Ni HC, Chiu YN, Shang CY, Wu YY, Lin LY, Tai YM, Soong WT (2010) Association between symptoms and subtypes of attention-deficit hyperactivity disorder and sleep problems/disorders. J Sleep Res. doi:10.1111/j.1365-2869.2010.00832.x
22. LeBourgeois MK, Avis K, Mixon M, Olmi J, Harsh J (2004) Snoring, sleep quality, and sleepiness across attention-deficit/hyperactivity disorder subtypes. Sleep 27(3):520–525
23. Mayes SD, Calhoun S, Bixler EO, Vgontzas AN (2009) Sleep problems in children with autism, ADHD, anxiety, depression, acquired brain injury, and typical development. Sleep Med Clin 4(1):19–25
24. Canivez GL, Konold TR, Collins JM, Wilson G (2009) Construct validity of the Wechsler Abbreviated Scale of Intelligence and Wide Range Intelligence Test: convergent and structural validity. Sch Psychol Q 24(4):252–265
25. Kaufman J, Birmaher B, Brent D, Rao U, Flynn C, Moreci P, Williamson D, Ryan N (1997) Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version (K-SADS-PL): initial reliability and validity data. J Am Acad Child Adolesc Psychiatry 36(7):980–988
26. Shaffer D, Gould MS, Brasic J, Ambrosini P, Fisher P, Bird H, Aluwahlia S (1983) A children's global assessment scale (CGAS). Arch Gen Psychiatry 40(11):1228–1231
27. Barkley RA, Murphy KR (1998) Attention-deficit hyperactivity disorder: a clinical workbook. 2nd edn. Guilford Press, New York
28. Gomez R (2007) Australian parent and teacher ratings of the DSM-IV ADHD symptoms: differential symptom functioning and parent–teacher agreement and differences. J Atten Disord 11(1):17–27
29. Owens JA, Spirito A, McGuinn M (2000) The Children's Sleep Habits Questionnaire (CSHQ): psychometric properties of a survey instrument for school-aged children. Sleep 23(8):1043–1051
30. Dahl RE (1996) The regulation of sleep and arousal: development and psychopathology. Dev Psychopathol 8:3–27
31. Picchietti DL, England SJ, Walters AS, Willis K, Verrico T (1998) Periodic limb movement disorder and restless legs syndrome in children with attention-deficit hyperactivity disorder. J Child Neurol 13(12):588–594
32. Gruber R, Sadeh A, Raviv A (2000) Instability of sleep patterns in children with attention-deficit/hyperactivity disorder. J Am Acad Child Adolesc Psychiatry 39(4):495–501
33. Goel N, Rao H, Durmer JS, Dinges DF (2009) Neurocognitive consequences of sleep deprivation. Semin Neurol 29(4):320–339
34. Killgore WD, Grugle NL, Reichardt RM, Killgore DB, Balkin TJ (2009) Executive functions and the ability to sustain vigilance during sleep loss. Aviat Space Environ Med 80(2):81–87
35. Hvolby A, Jorgensen J, Bilenberg N (2008) Actigraphic and parental reports of sleep difficulties in children with attention-deficit/hyperactivity disorder. Arch Pediatr Adolesc Med 162(4):323–329

36. Corkum P, Tannock R, Moldofsky H (1998) Sleep disturbances in children with attention-deficit/hyperactivity disorder. J Am Acad Child Adolesc Psychiatry 37(6):637–646
37. Owens J, Sangal RB, Sutton VK, Bakken R, Allen AJ, Kelsey D (2009) Subjective and objective measures of sleep in children with attention-deficit/hyperactivity disorder. Sleep Med 10(4):446–456
38. Holley S, Hill CM, Stevenson J (2010) A comparison of actigraphy and parental report of sleep habits in typically developing children aged 6–11 years. Behav Sleep Med 8(1):16–27
39. van Litsenburg RR, Waumans RC, van den BG, Gemke RJ (2010) Sleep habits and sleep disturbances in Dutch children: a population-based study. Eur J Pediatr 169(8):1009–1015
40. Liu X, Liu L, Owens JA, Kaplan DL (2005) Sleep patterns and sleep problems among schoolchildren in the United States and China. Pediatrics 115(1 Suppl):241–249