Use of Ball Blanket in attention-deficit/hyperactivity disorder sleeping problems

Article *in* Nordic journal of psychiatry · April 2011

DOI: 10.3109/08039488.2010.501868 · Source: PubMed

2 authors:

Allan Hvolby
Odense University Hospital
24 PUBLICATIONS **302** CITATIONS
SEE PROFILE

Niels Bilenberg
University of Southern Denmark
151 PUBLICATIONS **3,361** CITATIONS
SEE PROFILE

informa
healthcare

Use of Ball Blanket in attention-deficit/ hyperactivity disorder sleeping problems

ALLAN HVOLBY, NIELS BILENBERG

Hvolby A, Bilenberg N. Use of Ball Blanket in attention-deficit/hyperactivity disorder sleeping problems. Nord J Psychiatry 2011;65:89–94.

Objectives: Based on actigraphic surveillance, attention-deficit/hyperactivity disorder (ADHD) symptom rating and sleep diary, this study will evaluate the effect of Ball Blanket on sleep for a sample of 8–13-year-old children with ADHD. *Design:* Case–control study. *Setting:* A child and adolescent psychiatric department of a teaching hospital. *Participants:* 21 children aged 8–13 years with a diagnosis of ADHD and 21 healthy control subjects. *Intervention:* Sleep was monitored by parent-completed sleep diaries and 28 nights of actigraphy. For 14 of those days, the child slept with a Ball Blanket. *Main outcome measures:* The sleep latency, number of awakenings and total length of sleep was measured, as was the possible influence on parent- and teacher-rated ADHD symptom load. *Results:* The results of this study will show that the time it takes for a child to fall asleep is shortened when using a Ball Blanket. The time it takes to fall asleep when using the Ball Blanket is found to be at the same level as the healthy control subjects. Teacher rating of symptoms show an improvement in both activity levels and attention span of approximately 10% after using the Ball Blankets. *Conclusions:* The results of this study show that the use of Ball Blankets is a relevant and effective treatment method with regard to minimizing sleep onset latency. We find that the use of Ball Blankets for 14-days improves the time it takes to fall asleep, individual day-to-day variation and the number of awakenings to a level that compares with those found in the healthy control group. Furthermore, we find that the use of Ball Blankets significantly reduces the number of nights that the ADHD child spends more than 30 min falling asleep from 19% to 0%.

• *ADHD, Sleep, Treatment.*

Allan Hvolby, M.D., Ph.D., Department of Child and Adolescent Psychiatry, Region of Southern Denmark, Gl. Vardevej 101, 6715 Esbjerg N, Denmark, E-mail: hvolby@dlgmail.dk; Accepted 11 June 2010.

Attention-deficit/hyperactivity disorder (ADHD) is the most common problem presented to Child and Adolescent Mental Health Services (CAMHS). The disorder affects 3–5% of all school-aged children (1). The core symptoms of the disorder—inattention, hyperactivity and impulsivity—are associated with a high rate of comorbidity (e.g. oppositional defiant disorder, anxiety and depression; 2–4), as well as academic underachievement, poor social relations and sleep disturbances. Sleep difficulties was even included in the diagnostic criteria for ADHD in the DSM III (5) and are often included in ADHD rating scales, e.g. Conners' Rating Scale for parents (6).

It has been theorized that sleep deprivation in children with ADHD could be a result of a primary sleep disorder, or that it could be related to dysregulation of arousal mechanisms as implicated in the aetiology of ADHD (7). We know that sleep difficulties with no explanatory cause can be mistaken for ADHD (8), and that the kind of symptoms observed in primary sleep disorders—such as sleep-related breathing disorders or periodic limb movement disorders—can often be mistaken for ADHD, as they are very similar to core symptoms of ADHD. These disorders are found to be related to hyperactivity and inattentiveness (9–14), and the very treatment of the sleep disorders has reduced—or even cured—both hyperactivity and inattentiveness (15, 16). It has also been proposed that an unstable sleep schedule could be the result of biological immaturity, or it could be a dysfunction somehow related to inattentiveness. Likewise, it has been suggested that instability of the sleep–wake system may play a role in the irregularity of the arousal level (17).

Sleep problems are furthermore interesting because learning difficulties are rather frequent in children with ADHD (15), and several studies have documented a link between sleep disorder and learning difficulties (18–23).

Parents of children with ADHD often report that their child has sleep difficulties. Little need for sleep, difficulties

DOI: 10.3109/08039488.2010.501868

falling asleep, restless sleep, frequent awakenings and fatigue in the morning are often reported problems (24–26). The children themselves also report sleep difficulties more often than children without ADHD (27). Self-report studies show that more than half the children with ADHD report subjectively experienced sleep difficulties (24, 28, 29). This could be of great theoretical importance in the clinical work.

Recent studies point out that the majority of sleep difficulties found with reference to ADHD may result from a mix-up of comorbidity and medical treatment. Comparing children with ADHD against clinical controls, Mick et al. (30) found no significant sleep difficulties in children with ADHD when comorbidity (anxiety, oppositional defiant disorder and depression) and treatment with stimulants were taken into account, but only few studies have addressed this possible connection, and the picture is far from clear.

However, other studies have documented a higher degree of insomnia and more individual variation in time to sleep latency in medically naïve children with ADHD compared with children with other psychiatric diagnoses and healthy children (29, 31–35). It is difficult to judge the extent and nature of sleep problems in children with ADHD because the range of studies addressing this issue suffer from methodological problems (e.g. too small sample sizes, wavering diagnostic criteria and different status of medication and comorbidity; 4).

From clinical practice, we know that parents of children with ADHD are alarmed by their child's sleeping problems and the difficulties this causes in the family setting. The ADHD-diagnosed children themselves even report sleep difficulties more frequently than children without ADHD. More than half the children with ADHD claim to have sleep difficulties (25, 27, 28). In a study using actigraphy, Hvolby et al. (35) found increased sleep onset latency and an increased day-to-day variability in the sleep–wake pattern of children with ADHD compared with children without ADHD.

The design of the Ball Blanket (Fig. 1) is based on the American occupational therapist and psychologist, A. Jean Ayres's, theories of sensory integration (36). It works because the weight from the loose balls inside the blanket press certain points of the body, stimulating both the sensation of touch and the sense of muscle and joint. The many sensory impressions transmit inhibitory impulses to the central nervous system. This increases the sense of the body and its limits, and it provides confidence. The Ball Blanket has been used in psychiatric inpatient wards for some years as a tranquillizing method and has, in non-scientific and unpublished works, diminished the use of medical tranquilisers.

The Ball Blanket is produced with balls of various sizes and weights. The blanket with plastic balls provides most weight and pressure, and provides therefore the strongest stimulation of the sensory system. The Ball Blanket with a mixture of plastic and polystyrene balls is a somewhat lighter blanket for those who need slightly milder stimulation of the sensory system. The blanket with polystyrene balls provides the lightest stimulation of the sensory system. For this project, the Ball Blanket (adult size 140 × 200 cm) with 50-mm plastic balls and a weight of 7 kg has been used. For more information, see www.protac.dk

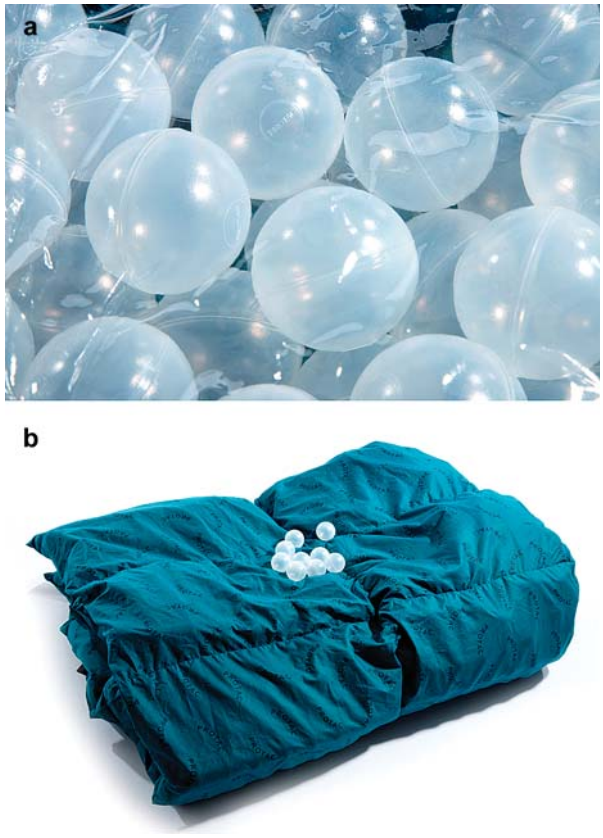

Fig. 1. The Ball Blanket.

Aims

Based on actigraphic surveillance, ADHD symptom rating (ADHD-RS; 37) and sleep diary, this study will evaluate the effect of Ball Blankets on sleep in a sample of 8–13-year-old ADHD children. The sleep latency, number of awakenings and total length of sleep will be measured, as will the possible influence on parent- and teacher-rated ADHD symptom load.

Methods

Participants

A total of 21 children (19 boys and two girls) aged 8–13 years, with an average age of 10.0 years, were involved. All had been referred to a child and adolescent

psychiatric department and diagnosed with ADHD. Fourteen children were medicated with methylphenidate, two with dexamphetamine sulphate and two with atomoxetine. One child was treated with a combination of methylphenidate and atomoxetine and two children were not medicated. Three children got melatonin at bedtime. All medications remained unchanged during the test period.

None of the participating children had been referred for sleeping problems nor did they have major sensory-motor handicaps (blindness, deafness and paralysis), autism and psychosis. All had an estimated full-scale IQ above 80.

Psychiatric comorbidity is shown in Table 1.

Diagnostic measures

Each participant in the referred group was subjected to thorough clinical assessment. The diagnostic evaluations were based on face-to-face parent interviews and a clinical assessment, and the hyperkinetic disorder (ADHD) was diagnosed in accordance with the ICD-10 Classification of Mental and Behavioural Disorder.

Table 1. Descriptive characteristics of children and parents.

	ADHD	Healthy control
Age (*s*)	10.0 (1.7)	9.8 (0.4)
Gender		
Male	19	20
Female	2	1
Family type		
Two-parent family*	17	16
Other	4	5
Social class		
Self-employed	3	1
Salary-earner	16	19
Student	2	0
Transfer income	0	0
Unknown	0	1
Psychiatric comorbidity		
Anxiety disorder	2	
Learning disability	4	
PDD-NOS	1	
Oppositional defiant disorder	1	
Conduct disorder	1	
Tourettes Syndrome	1	
Somatic diagnoses		
Asthma	1	0
Medication		
Stimulants	16	(dose interval 5–74 mg)
Atomoxetin	2	(dose interval 25–40 mg)
Stimulant + atomoxetin	1	
Melatonin	3	(dose 3 mg)
Alternative medicine	1	

ADHD, attention-deficit/hyperactivity disorder; *s*, standard deviation; PDD-NOS, pervasive developmental disorder—not otherwise specified.
*Two parents in the family. Two biological parents or one biological parent and his/her cohabiting partner.

Sleep

To obtain an objective view of the sleep pattern, actigraphs (Basic Mini Motionlogger, Ambulatory Monitoring Inc., New York)—a wrist-watch-sized activity sensor worn on the dominant wrist—was used. Actigraphy is an established and well-reputed method of sleep examination. Findings are consistent with those obtained by the polysomnographic methods, with an agreement rate of 95% (38). Sleep recording took place in the children's own home, which is an additional advantage, as the children's sleep does not seem to have been negatively affected (39).

The children wore the actigraph for a consecutive period of 28 nights (40). Surveillance took place in three consecutive periods; first 7 nights without the Ball Blanket to obtain the baseline sleeping pattern, then 14 nights using the Ball Blanket and finally 7 nights without the blanket.

When uploaded to the computer, the accumulated data was analysed according to the Actigraphic Scoring Analysis Program (41). Study of frequency and pattern of movement permits detection of basic sleep–wake patterns. The variables generated were 'sleep onset latency' (time between parents noting lights out and actigraphically measured first sleep onset), 'number of wakes after sleep onset', 'length of each wake' and 'total duration of sleep' (actual sleep time, excluding sleep latency and wakes after sleep onset).

During the same 7–14–7 night period, a sleep diary was completed by the parents to provide a subjective assessment of sleep–wake patterns and to provide more accurate actigraphical measurements. Parents were instructed to observe and specify their children's sleeping and waking states (bedtime, lights out, observed wakes and times the child woke up). Thus we were able to calculate sleep onset latency (time between parents noting lights out and actigraphically measured first sleep onset). Also, parents and teachers rated the load of inattentive and hyperactive/impulsive symptoms on the ADHD-RS at the end of each period.

As a control group, 21 matched children were sampled from a Danish actigraphic norm-population (42).

Results

The results of this study (Table 2) show that sleep onset latency was reduced when using the Ball Blankets. Without the use of Ball Blankets, the average sleep onset latency was 23.1 min, which fell to 14.0 min when using the Ball Blanket—a fall of 39.4%. The time it took for the child to sleep can furthermore be seen as being at the same level as sleep onset latency for healthy control children—whilst the time increases—to 20.5 min—when the blanket is removed.

There is likewise an improvement in the average of individual longest sleep onset latency. The difference between the longest and shortest individual sleep onset

Table 2. Actigraphic sleep parameters.

	Before Ball Blanket	With Ball Blanket	After Ball Blanket	Healthy controls	*P*-value
		$n = 21$		$n = 21$	
Sleep onset latency (minutes), mean (*s*)	23,1 (9.4)	14,0 (6.1)	20.5 (11.7)	14.2 (10.0)	$P < 0.002$
Average of longest sleep onset latency (minutes), mean (*s*)	44.7 (27.2)	32.1 (14.2)	38.8 (19.6)	25,3 (17,1)	ns
Difference between longest and shortest individual sleep onset latency (minutes), mean (*s*)	36.9 (24.8)	30.2 (14.6)	29.8 (15.7)	20.8 (20.0)	ns
Number of awakening (number), mean (*s*)	7,7 (5.6)	6,1 (3.8)	6,4 (4.6)	7,8 (4,8)	ns
Average time awake (minutes), mean (*s*)	3,3 (1.5)	3,6 (1.7)	3,2 (3.3)	2,9 (1,6)	ns
Total sleep time (minutes), mean (*s*)	510 (50.3)	524 (26.4)	487 (117)	579 (32,6)	ns
Sleep onset latency (average) >30 min (%)	19.0%	0%	19.0%	4.8%	$p = 0.035^*$
(n = total number of nights in each group)	($n = 130$)	($n = 243$)	($n = 107$)	($n = 147$)	
Sleep onset latency >30 min (%)	27.7%	14.8%	33.6%	12,4%	$P < 0.003^*$
Sleep onset latency <15 min (%)	38.5%	68.7%	47.7%	na	$P < 0.001^*$

s, standard deviation; ns, not significant (significance level $P < 0.01$).
Actigraphic sleep parameters in minutes averaged for each child, and fraction of children with an average sleep onset latency >30 min.
Data analysed with one-way analysis of variance (ANOVA).
*Chi-squares with two degrees of freedom.

latency and the average number of awakenings during the night was between 18% and 28%.

An interesting find is that the proportion of children that spent longer than 30 min on average falling asleep; 19% spent more than 30 min on average falling asleep before and after using the Ball Blanket, whilst no children had an average of more than 30 min when using the blanket.

Likewise, the proportion of single nights when more than 30 min were spent falling asleep fell from 27.7% to 14.8% when using the blanket, which is the same level as the healthy control children. At the same time, the proportion of single nights during which the child fell asleep within 15 min rose from 38.5% to 68.7%.

Table 2 shows that the sleep parameters described deteriorate again when the Ball Blanket is not used.

Parents' evaluation of the sleep is shown in Table 3. Parents experience that their child falls asleep more quickly, even if the subjective effect is small than with the actigraph measurement. Likewise, parents evaluate that the sleep onset latency falls from an average of 36.7 min to 26.9 min, which is an improvement of 26.7%.

Parents have a tendency to overestimate the length of time it takes to go to sleep, both in the period with and without the use of the Ball Blanket. However, as the table shows, this phenomenon is found at the same level in the healthy control group.

In Tables 4a and 4b, the ratings of ADHD symptoms are shown from teachers and parents respectively. Teacher ratings show a non-significant improvement in both activity level and attention—approximately 10% from before the Ball Blanket is used to scoring after 14 nights with the Ball Blanket. The tables also show a continued, further improvement in both parameters in the week after the Ball Blanket has been removed again.

Parent rating shows the same tendency, though with a smaller improvement in activity and attention, but with an improvement in behavioural disturbance symptoms of 13%.

Discussion

Previous studies found that non-medicated children with ADHD had longer sleep onset latency, and that

Table 3. Parental versus actigraphic estimated sleep onset latency.

Sleep onset latency	Before Ball Blanket	With Ball Blanket	After Ball Blanket	Healthy controls	*P*-value
Actigraphic measure, mean (*s*)	23.1 (9.4)	14.0 (6.1)	20.5 (11.7)	14.2 (10.0)	$P < 0.002$
Parental estimation, mean (*s*)	36.7 (21.6)	26.9 (9.4)	31.8 (16.9)	24.8 (11.1)	$P < 0.01$
Difference (between actigraphic and parent est.), mean (*s*)	13.6 (21.5)	12.9 (8.2)	11.3 (16.8)	10.6 (9.9)	$P < 0.01$
Number of parents who overestimate (%)	76.5%	93.8%	86.7%	75.0%	ns

s, standard deviation; ns, not significant (significance level $P < 0.01$).
Parents' estimation (by sleep diary) of sleep onset latency (time between *parents noting* lights out and *parents noting* first sleep onset), compared with the objectively (actigraphically) measured sleep onset latency (time between *parents noting* lights out and *actigraphically* measured first sleep onset).
*Data analysed with three-way analysis of variance (ANOVA), adjusted for gender and family type.

Table 4a. Attention-deficit/hyperactivity disorder (ADHD) rating scale (score (standard deviation))—rated by teachers.

	Without Ball blanket	With Ball blanket	Without Ball blanket after	Difference	*P*-value*
Hyperactivity	14.6 (7.9)	13.1 (7.3)	12.5 (6.8)	10.5%/14.4%	ns
Inattention	12.8 (6.6)	11.5 (6.7)	10.8 (6.2)	10.2%/15.6%	ns
Total	27.4 (14.2)	24.6 (14.1)	23.3 (12.6)	10.2%/15.0%	ns
Behaviour	6.2 (5.8)	6.4 (6.4)	5.6 (4.9)	–/9,7%	ns

*Wilcoxon Rank sign test.

significantly more children with ADHD spend more than 30 min (on average) falling asleep (35). An increased intra-individual day-to-day variability in sleep onset latency in children with ADHD compared with healthy children and children with other psychiatric diagnoses has also been documented (16).

Previous studies (8–11, 35) show a relationship between sleep difficulties and an increased magnitude of ADHD symptoms, inattention and hyperactivity. Treatment with Ball Blankets appears therefore to improve sleep and this study has furthermore shown a small decrease in the severity of ADHD symptoms, as evaluated by both teachers (approximately 10% improvement), and by parents (approximately 6%). In both evaluations, the improvement appears to continue even when use of the Ball Blanket has stopped.

In accordance with other studies (31–33, 35), we found poor correspondence between parental recordings of sleep problems and the objective measurements (actigraphy). We found disagreement both with and without the use of Ball Blankets. Corkum et al. (43) claims that the lack of correspondence between objective and subjective measurements of especially sleep onset latency, which is the most frequently reported problem area, is related to the children's problematic behaviour around bedtime. In addition, the individually based day-to-day variation in the sleep pattern of children with ADHD found in this study may well contribute towards making the problem appear greater than it really is. These phenomena may play an important role in parents' experiences of their child's problems falling asleep. Parents may recall "worst case" scenarios.

Other studies have highlighted the importance of sleep in relation to learning difficulties, behaviour, concentration and motor skills disturbances. Treating sleep problems in children with ADHD is therefore relevant (9–14, 18–23).

The results of this study show that the use of Ball Blankets is a relevant and effective method of treatment with regard to reducing sleep onset latency

We find that the use of Ball Blankets for 14 days improves sleep onset latency, individual day-to-day variation and number of awakenings to a level comparable with those found in the healthy control group.

We furthermore find that the use of Ball Blankets significantly reduces the number of nights in which the ADHD child spends more than 30 min falling asleep from 19% to 0%.

The weakness in this study is the relatively small study group and the short length of time in which the Ball Blanket was used. It is conceivable that a longer period using the Ball Blanket would give more significant results, especially with regard to improving ADHD symptoms. The present study has not included possible differences between subtypes of ADHD. This study has not examined whether medication with central stimulating medicine has any effect on the results.

As far as we are aware, this is a unique study that demonstrates that the Ball Blanket can be a good alternative when treating sleep difficulties in children with ADHD and a supplement to medical treatment for its core symptoms.

Acknowledgements—The authors has no conflicts of interest
Financial support: The project is financially supported by Protac.
The author has no obligations to Protac regarding this manuscript.

Table 4b. Attention-deficit/hyperactivity disorder (ADHD) rating scale (score (standard deviation))—rated by parents.

	Without Ball blanket	With Ball blanket	Without Ball blanket after	Difference	*P*-value*
Hyperactivity	15.1 (5.9)	14.2 (5.5)	14.1 (5.9)	6.0%/6,6%	ns
Inattention	12.5 (6.4)	11.7 (5.9)	11.5 (5.8)	5.6%/8.0%	ns
Total	27.6 (12.0)	25.9 (11.2)	25.6 (11.3)	6.2%/7.2%	ns
Behaviour	8.4 (5.9)	7.3 (5.1)	7.3 (4.7)	13.1%/13.1%	ns

*Wilcoxon Rank sign test.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 4rd edition (DSM-IV). Washington, DC: American Psychiatric Association; 1994.
2. Biederman J, Faraone S, Milberger S, Guite J, Mick E, Chen L, et al. A prospective 4-years follow-up study of attention-deficit hyperactivity and related disorders. Arch Gen Psych 1996;53: 437–46.
3. Barkley RA, Attention-deficit hyperactive disorder, a clinical workbook. New York: Guilford Publications Inc., 1998.
4. Corkum P, Moldofsky H, Hogg-Johnson S, Humphries T, Tannock R. Sleep problems in children with attention-deficit/ hyperactive disorder: Impact of subtype, comorbidity, and stimulant medication. J Am Acad Child Adolesc Psychiatry 1999;38:1285–93.
5. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 3rd edition, revised (DSM-III-R). Washington DC: American Psychiatric Association; 1987.
6. Goyette CH, Conners CK, Ulrich RF. Normative data on revised Conners Parent and Teacher Rating Scales. J Abnorm Child Psychol 1978;6:221–36.
7. Barkley RA. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. Psychol Bull 1997;121:65–94.
8. Hvolby A, Bilenberg N, Jørgensen JI. Søvnrytmeforstyrrelse kan ligne symptomer på opmærksomhedsforstyrrelse. Ugeskr Læger 2005;167:3893.
9. Chervin RD, Dillon JE, Bassetti C, Ganoczy DA, Pituch KJ. Symptoms of sleep disorders, inattention, and hyperactivity in children. Sleep 1997;20:1185–92.
10. Chervin RD, Archbold KH. Hyperactivity and polysomnographic findings in children evaluated for sleep-disordered breathing. Sleep 2001;24:313–20.
11. Chervin RD, Archbold KH, Dillon JE, Panahi P, Pituch KJ, Dahl RE, Guilleminault C. Inattention, hyperactivity, and symptoms of sleep-disordered breathing. Pediatrics 2002;109: 449–56.
12. Divgi V. What about sleep? Arch Pediatr Adolesc Med 2000;154:636.
13. Picchietti DL, England SJ, Walters AS, Willis K, Verrico T. Periodic limp movement disorder and restless legs syndrome in children with attention-deficit hyperactive disorder. J Child Neurol 1998;13:588–94.
14. Picchietti DL, Underwood DJ, Farris WA, Walters AS, Shah MM, Dahl RE, et al. Further studies on periodic limp movement disorder and restless legs syndrome in children with attention-deficit hyperactive disorder. Movement Dis 1999;14: 1000–1007.
15. Walters AS, Mandelbaum DE, Lewin DS, Kugler S, England SJ, Miller M. Dopaminergic therapy in children with restless legs/ periodic limb movements in sleep and ADHD. Pediatr Neurol 2000; 22:182–6.
16. Gruber R, Sadeh A, Raviv A. Instability of sleep patterns in children with attention deficit hyperactive disorder. J Am Acad Child adolesc Psychiatry 2000;39:495–501.
17. Aronen E T, Paavonen E J, Fjällberg M, Soininen M, Törrönen J. Sleep and psychiatric symptoms in school-age children. J Am Acad Child adolesc Psychiatry 2000;39:502–508.
18. Taras H, Potts-Datema W. Sleep and student Performance. School J School Health 2005;75:248–54.
19. Sadeh A, Gruber R, Raviv A. Sleep, neurobehavioural functioning and behavioral problems in school-aged children. Child Devel 2002;73:404–17.
20. Marcotte AC, Thatcher PV, Butters M, Bortz J, Acebo C, Carscadon MA. Parental report of sleep problems in children with attentional and learning disorders. Devel Behav Pediat 1998;19:178–86.
21. Mercier L, Pivik RT, Busby K. Sleep pattern in reading disabled children. Sleep1993;16:207–15.
22. Dahl RE. The impact of inadequate sleep on children's daytime cognitive function. Pediat Neurol 1996;3:44–50.
23. Kaplan BJ, McNicol J, Conte RA, Moghadam HK. Sleep disturbance in preschool-aged hyperactive and non hyperactive children. Paediatrics 1987;80:839–44.
24. Trommer B, Hoeppner JB, Rosenberg RS, Armstrong KJ, Rothstein JA. Sleep disturbance in children with attention deficit disorder. Annals Neurol 1988;24:322.
25. Dall RE, Puig-Antich J. Sleep disturbances in child and adolescent psychiatric disorders. Paediatrics 1990;17:32–7.
26. Owens J A, Maxim R, Nobile C, McGuinn M, Msall M. Parental and self-report of sleep in children with attention deficit hyperactive disorder. Arch Pediatr Adolesc Med 2000;154:549–55.
27. Ball J D, Tiernan M, Janusz J, Furr A. Sleep patterns among children with attention deficit hyperactive disorder. A re-examination of parent perception. J Paediat Psychol 1997;22:389–98.
28. Greenhill L, Puig-Antic J, Goetz R, Hanlon C, Davies M. Sleep architecture and REM sleep measures in prepubertal children with attention deficit disorder with hyperactivity. Sleep 1983;6:91–101.
29. Corkum P, Moldofsky H, Hogg-Johnson S, Humphries T, Tannock R. Sleep problems in children with attention-deficit/hyperactive disorder: Impact of subtype, comorbidity, and stimulant medication. J Am Acad Child Adolesc Psychiatry 1999;38:1285–93.
30. Mick E, Biederman J, Jetton J, Faraone S V. Sleep disturbance associated with attention deficit hyperactive disorder: The impact of psychiatric comorbidity and pharmacotherapy. J Child and Adol Psychopharmacol 2000;10:223–31.
31. Konofal E, Lecendreux M, Bouvard M P, Mouren-Simeoni M-C. High levels of nocturnal activity in children with attention deficit hyperactive disorder. A video analysis. Psychiatry Clin Neurosci 2001;55:97–103.
32. Lecendreux M, Konofal E, Bouvard M P, Mouren-Simeoni M-C, Falissard B. Sleep and alertness in children with ADHD. J Child Psychol Psychiatry 2000;41:803–12.
33. Palm L, Persson E, Bjerre I, Elmquist D, Blennow G. Sleep and wakefulness in preadolescent children with deficits in attention, motor control and perception. Acta Pædiatr 1992;81:618–24.
34. Busby K, Firestone P, Pivik R T. Sleep patterns in hyperkinetic and normal children. Sleep 1981;4:366–83.
35. Hvolby A, Jørgensen J, Bilenberg N. Actigraphic and parental reports of sleep difficulties in children with attention-deficit/ hyperactivity disorder. Arch Pediatr Adolesc Med 2008;162:323–9.
36. Ayres, A. Jean. Sensory integration and the child. Los Angeles, CA: Western Psychological Services; 1982.
37. DuPaul GJ, Power TJ, Anastopoulos A, Reid R. ADHD rating scale—IV. New York: The Guilford Press; 1998.
38. Sadeh A, Alster J, Urbach D, Lavie P. Actigraphically based automatic bedtime sleep–wake scoring: Validity and clinical applications. J Ambulat Monitor 1989;2:209–216.
39. Sadeh A, Lavie P, Scher A, Tirosh E, Epstein R. Actigraphic home-monitoring sleep-disturbed and control infants and young children: A new methods for pediatric assessment of sleep–wake patterns. Pediatrics 1991;87:494–9.
40. Acebo C, Sadeh A, Seifer R et al. Estimating sleep patterns with monitoring in children and adolescent: How many nights are necessary for reliable measures? Sleep 1998;22:95–103.
41. Action4 version 1.05, Ambulatory Monitoring, Inc.
42. Hvolby A, Jørgensen J, Bilenberg N. Søvn og søvnproblemer hos danske børn i alderen 6–11 år. Ugeskr Læger 2008;170:448–51.
43. Corkum P, Tannock R, Moldofsky H. Sleep disturbance in children with attention deficit hyperactive disorder. J Am Acad Child Adolescent Psychiatry 1998;37:637–46.

Allan Hvolby, M.D., Ph.D., Department of Child and Adolescent Psychiatry, Region of Southern Denmark, Gl. Vardevej 101, 6715 Esbjerg N, Denmark.
Niels Bilenberg, M.D., Ph.D., Professor, Department of Child and Adolescent Psychiatry, Region of Southern Denmark, University Hospital of Odense, Sdr. Boulevard 29, 5000 Odense, Denmark.