Original Article

Sleep Disturbances in Singaporean Children with Attention Deficit Hyperactivity Disorder

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Abstract

Introduction: Many studies have reported various levels of association between sleep disorders and attention deficit hyperactivity disorder (ADHD). This study aims to investigate sleep disturbances in children with ADHD prior to treatment and during treatment. Materials and Methods: This study recruited 114 child and adolescent patients diagnosed with ADHD and 60 normal patients. Sleep disturbances are assessed using the parent-rated Child Behaviour Checklist (CBCL) questionnaire. In addition, chart reviews and semi-structured clinical interviews were conducted for 54 patients with ADHD who had been seen at the clinic since 2002 to examine the sleep disturbances they experienced during treatment over a 4-year period. Results: Compared to the normal subjects, parents of children with ADHD reported that their children slept less. The summation score of the sleep items on the CBCL was also significantly higher in the ADHD group. Girls with ADHD also had more "trouble sleeping". When children with ADHD received treatment with medications, they experienced sleep-related side effects. Out of the 54 children with ADHD, 18.5% experienced sleep disturbance related to medication, with 13.0% reporting daytime somnolence and 5.5% reporting insomnia. Conclusion: Our study showed that there was an increased frequency of sleep disturbances in children with ADHD prior to treatment with medications. The children in our study appeared to sleep less. A significant proportion also experienced sleep disturbance during treatment with medication, of which daytime somnolence and insomnia were the most commonly reported problems. Future research in this area is needed to further examine the range of sleep disorders in ADHD children locally.

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Key words: Child Behaviour Checklist, Insomnia, Methylphenidate

Introduction

Attention deficit hyperactivity disorder (ADHD) is a common childhood psychiatric disorder with various studies reporting prevalence rates of between 1.7% and 16%.[1] The most current version of the Diagnostic and Statistical Manual of Diseases (DSM), fourth edition,[2] has 2 lists of behavioural symptoms grouped under "inattentive" and "hyperactive-impulsive" symptoms, respectively. While there are reports that many children, adolescents and adults with ADHD experience chronic sleep difficulties,[3] there is no symptom in DSM that relates to any form of sleep disturbance. In the third edition of DSM, one of the symptoms listed under hyperactivity symptoms was "moving about excessively during sleep".[4] Yet, interest in research on sleep disturbance in children with ADHD has only been recent.[5]

The literature on sleep problems in children with ADHD has varied findings. Several studies have reported an increased prevalence rate of ADHD in an enuretic population,[6,7] with one study reporting that older enuretic children (aged 9 to 12 years) had higher prevalence of ADHD.[8] One meta-analysis found that children with ADHD are more likely to suffer from periodic limb movement in sleep,[9] and it has been postulated that the underlying neuro-chemical basis may be dopaminergic deficit.[10] Another recent review found increased night-time activity, reduced rapid eye movement sleep, and significant daytime somnolence in unmedicated children with ADHD.[11]

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Children with ADHD were more likely to experience sleep talking, restless sleep, enuresis, unwillingness to go to sleep,[12] difficulty initiating sleep, night awakening and snoring.[4] In adolescents, short sleep duration has been reported to be associated with a higher risk of ADHD.[13]

There have also been many studies investigating the relationship between ADHD and sleep-disordered breathing (SDB) problems.[11] There is concern that because children with sleep disorders are often inattentive or hyperactive, some of them may be mistakenly diagnosed with ADHD.[14] SDB can lead to mild ADHD-like behaviours and cause confusion, with resultant delay in diagnosis and appropriate treatment.[15] Children with obstructive sleep apnoea[16] and habitual snoring[17] have presented with inattentive and hyperactive symptoms, and possibly up to one third of all children with frequent, loud snoring or SDB will show significant hyperactivity and inattention.[18] With treatment of these respiratory sleep disturbances, the ADHD-like symptoms improved.[19] Another group of patients proposed to be at risk of ADHD are obese adolescents observed by parents to be excessively sleepy.[20] One prospective study of infants with severe sleep problems has also reported that up to a quarter could develop ADHD in childhood.[21]

Polysomnography has also been used to investigate sleep patterns in children with ADHD. Findings in children with ADHD include ADHD reduced sleep duration and increased rate of stage shifts.[22] Investigation into the genetic basis for sleep disturbances has also been done. One study found differences in sleep continuity between children with ADHD with different alleles of the COMT (catechol-O-methyltransferase) gene.[23]

Probably what is more familiar to doctors treating children with ADHD would be sleep problems related to medication. In Singapore, the main stimulant medication used is methylphenidate, which comes in various preparations. Insomnia is reported with methylphenidate use[24,25] and up to one third may experience insomnia or increased sleep latency.[26] Some doctors have tried to prevent this by omitting late evening methylphenidate doses. Sleep may also moderate performance in children with ADHD who are treated with methylphenidate.[27] Atomoxetine, a relatively new non-stimulant first-line treatment for ADHD, has been associated with a lower incidence of insomnia than methylphenidate.[25] Other medications which can be used to treat ADHD such as antidepressants or even antipsychotic medication can also cause drowsiness. Conversely, studies in adults suggested that methylphenidate might improve sleep quality and nocturnal motor activity.[28,29]

There is paucity of knowledge about the prevalence of sleep-related problems in our population of ADHD children. The study reported here is designed to investigate if there is any increased frequency of sleep-related problems in children with ADHD. We hypothesise that children with ADHD will have increased sleep disturbances at baseline compared with normal controls.

Materials and Methods

The patient samples used for the study were selected from those used in 2 other studies. The first study was originally designed to validate the Child Behaviour Checklist (CBCL) questionnaire[30] for the diagnosis of ADHD, and the second study was designed to examine the outcomes of children with ADHD. For this paper, we used the results of the studies to test the hypothesis that there is no difference in the prevalence of sleep-related problems between patients with and without ADHD. The design of the studies was retrospective. Approval for the studies was obtained from the hospital and healthcare cluster ethical review board.

One hundred and twenty patients were recruited for the first study. They were consecutive new patients seen at the Child Guidance Clinic, which is the outpatient clinic of the state mental institution attending to young patients below the age of 19. Children and adolescents with a clinical diagnosis of ADHD, made over a 6-month period from March to August 2005, were recruited. To ensure that the diagnosis was accurate, the medical record of every patient was examined for documented ADHD symptoms to ensure that they fulfilled the DSM-IV criteria. With the consolidated list of symptoms, each patient would then be classified into the subtype of ADHD (inattentive, hyperactive-impulsive or combined) according to DSM-IV criteria. In order to further ensure that the diagnosis of ADHD was accurate, the medical records were also reviewed to ensure that the attending psychiatrist obtained information from the child's schoolteachers as well, in addition to the parents or caregivers. Through this method, a total of 60 children with ADHD were recruited (Group 1). Another 60 patients, who received the diagnosis coded as "normal variation", and who were matched for age, gender and race with the subjects with ADHD, were recruited among all new patients who attended the clinic during the same 6-month period, to act as controls (Group 2). In our clinic, the clinicians used the diagnosis code of "normal variation" for patients who were not diagnosed with any formal psychiatric disorder and were not prescribed psychiatric medications. We used results from the CBCL questionnaires completed by the parents or caregivers during the first clinic visit for the patients in both groups to compare the frequency of positive reporting for sleep problems.

We also included 54 patients who were newly diagnosed with ADHD at the Child Guidance Clinic in 2002. They had participated in a follow-up study to examine their outcomes. We used the baseline CBCL results available for

41 of these patients for the analysis of baseline sleep problems. Details regarding treatment and medication-related side effects were obtained through chart reviews and interviews with the parents and children. During interviews, parents and children were separately asked if the children experienced any side effects to medication used to treat ADHD. If they answered "yes", they were then asked to list the side effects. In our analysis, we included only those side effects which were sleep-related.

The CBCL was used in this study to identify if there is a difference between baseline sleep problems in children with ADHD compared with normal controls. The CBCL is a parent-rated questionnaire designed to obtain descriptions of a child's competencies and behavioural/emotional problems. The last 2 pages of the questionnaire consist of 118 "problem items". Parents are instructed to score each item that "describes your child now or within the past 6 months' as follows: 0 = Not True; 1 = Somewhat or Sometimes True; 2 = Very True or Often True. The CBCL/6-18 scoring profile provides raw scores, T scores, and percentiles for 8 syndromes (Aggressive Behavior; Anxious/Depressed; Attention Problems; Rule-Breaking Behavior; Social Problems; Somatic Complaints; Thought Problems; and Withdrawn/Depressed) and Internalising, Externalising and Total Problems. Although there is no total score for sleep problems, the problem items include 6 sleep-related problems (Table 1).

Results

The baseline demographic characteristics for the ADHD and "normal variation" patients are summarised in Table 2. There were a total of 114 ADHD patients and 60 "normal variation" patients. The ADHD group consisted of 102 (89.5%) males and 12 (10.5%) females in the age range of 5 to 13 years (mean age, 8.0 ± 1.8 for the study group against 8.3 ± 1.9 for the control group). Chinese was the predominant race in each group (81.6% in the ADHD group and 78.3% in the normal variation group), paralleling the racial distribution of the country's population. Using chi-square analysis and independent sample *t*-test to compare the demographic factors, we did not find any statistical significance in any demographic variable between the 2 groups.

We proceeded to analyse the CBCL for the 2 groups of patients. However, for the ADHD group, 13 patients did not complete the baseline CBCL, thereby giving 101 questionnaires available for analysis. Out of the 8 "syndromes" yielded from scoring the questionnaire, there are 3 that relate to the symptoms of ADHD: "Attentional Problem", "Aggression Problem" and "Delinquent Behaviours". Two of 3 "Problem scores" are also relevant: "Externalising Problem" and "Total Problem". The raw score for each of these areas can be converted to a T-score. The T-score cut off for "clinical problem" for each subscale is 70.

Table 3 summarises the number of subjects who met the cut-off scores of 70 for each "syndrome" and "problem" that was related to ADHD. The proportion of children in the study group yielding T-scores in the "clinical problem" range was higher in all these 5 subscales. Analyses from chi-square revealed that a significant number of children with ADHD reported Attentional Problem (χ^2 (1, 160) = 19.95, $P = 0.001$), Aggression Problem (χ^2 (1, 160) = 5.84, $P = 0.02$), Delinquent Behaviours (χ^2 (1, 160) = 7.80, $P = 0.001$), Externalising Problem (χ^2 (1, 160) = 6.20, $P = 0.01$), and Total Problem (χ^2 (1, 160) = 11.30, $P = .001$).

Table 1. The Six Sleep-related Problem Items in Child Behaviour Checklist

Item no. in questionnaire	Item description
47	Nightmares
76	Sleeps less than most kids
77	Sleeps more than most kids during day and/or night
92	Talks or walks in sleep
100	Trouble sleeping
108	Wets the bed

Table 2. Demographic Characteristics of Study Participants

	ADHD patients (n = 114)	"Normal variation" patients (n = 60)
Age* (y)		
Range	5-13	5-13
Mean	8.0 ± 1.8	8.3 (1.9)
Gender		
Male	102 (89.5)	53 (88.3)
Female	12 (10.5)	7 (11.7)
Race		
Chinese	93 (81.6)	47 (78.3)
Malay	9 (7.9)	7 (11.7)
Indian	8 (7.0)	6 (10.0)
Others	4 (3.5)	0
ADHD subtype		
Combined subtype	76 (66.7)	NA
Inattentive subtype	36 (31.6)	NA
Hyperactive-impulsive subtype	2 (1.8)	NA

ADHD: attention deficit hyperactivity disorder; NA: not applicable
Results indicated as no. (%) or no. (SD)
* Age was taken as the age at administration of the questionnaire, which coincided with the age at first clinic visit

Table 3. Number (Proportion) of Subjects With T-Score Above 69 ("Clinical Problem' Cut-off Score) in Each Group

Subscales	Group 1 (ADHD) (n = 101)	Group 2 (Control) (n = 60)	χ^2
Attentional problem	47 (46.5)	7 (11.7)	19.96†
Aggression problem	24 (23.8)	4 (6.7)	5.84*
Delinquent behaviours	22 (21.8)	4 (6.7)	7.80†
Externalising problem	24 (23.8)	5 (8.3)	6.20*
Total problem	36 (35.6)	7 (11.7)	11.30†

ADHD: attention deficit hyperactivity disorder, values represent no. (SD)
*P <0 .05, †P <0.01.

Table 4. Frequency of Responses for the Six Sleep Problem Related Items of CBCL

Variable	Nightmares	Sleeps less*	Sleeps more	Sleep-talk or walk	Trouble sleeping	Wets bed	Mean total score†* (SD)
Group 1 ADHD (n=101)							1.73 (1.91)
Not True	64 (63.4)	64 (63.4)	88 (87.1)	85 (84.2)	77 (76.2)	82 (81.2)	
Somewhat True	32 (31.7)	27 (26.7)	8 (7.9)	13 (12.9)	17 (16.8)	11 (10.9)	
Very True	5 (5.0)	10 (9.9)	5 (5.0)	3 (3.0)	7 (6.9)	8 (7.9)	
Group 2 Control (n=60)							1.2 (1.42)
Not True	37 (61.7)	49 (81.7)	55 (91.7)	54 (90.0)	50 (83.3)	55 (91.7)	
Somewhat True	21 (35.0)	6 (10.0)	4 (6.7)	6 (10.0)	8 (13.3)	3 (5.0)	
Very True	2 (3.3)	5 (8.3)	1 (1.7)	0	2 (3.3)	2 (3.3)	
Odds Ratio	0.93 (0.48-1.79)	2.57 (1.19- 5.56)	1.63 (0.55- 5.81)	1.69 (0.62- 4.60)	1.56 (0.69- 3.54)	2.55 (0.90- 7.23)	

ADHD: attention deficit hyperactivity disorder; CBCL: Child Behaviour Checklist; SD: standard deviation
All results are presented as no. (%) or no. (SD). For the analysis, we compared the frequency of "not true" responses against the combined frequency of "somewhat true" and "very true" responses.
* P <0.05
† The total score is calculated for each subject by adding up the scores on the 6 sleep items. The mean total score is the mean of the total scores for each study group.

Table 4 summaries the responses for each of the 6 sleep-related problem items for both groups. The results of both the study and control groups were compared for the frequency of negative (parents reporting "not true") and positive (parents either reporting "somewhat or sometimes true" or "very true or often true") responses. Analyses from chi-square revealed that a significant number of children with ADHD reported less sleep problem, $\chi^2(1, 161) = 6.02$, $P = 0.01$. The results were further analysed by adding up the scores for all 6 sleep-related problem items for each patient to yield a "total score". Analyses from the *t*-test revealed that ADHD children had significantly higher levels of sleep-related problems compared to the control group, $t(1, 159) = 2.22$, $P = 0.03$.

Table 5 shows the characteristics of the 54 patients who were followed up from 2002. Their age ranged from 9 to 17 years (mean, 12.6 ± 1.4) during the study period. Forty-one (75.9%) had ever received medication for ADHD, with 12 (22.2%) still being treated with medication at present. Thirteen (24.1%) patients were never prescribed medication for ADHD. Among those who were treated with medication, the mean duration of treatment was 18.5 ± 17.7 months (range, 1 to 60). The mean duration of follow-up for all 54 patients was 35.4 ± 23.2 months (range, 1 to 60).

The case-notes for all 54 participants did not record any complaint regarding sleep-related problems during the first clinic visit prior to the administration of medication. At our clinic, the only stimulant medication available was methylphenidate, which comes in different types of preparations: short-acting preparation (henceforth referred to as "methylphenidate"), and extended-released preparations. Alternative medications for treating ADHD include atomoxetine and other antidepressants.

During the course of treatment, only 3 out of the 41 (7.3%) patients who received medication had sleep-related complaints recorded in the case records: 2 children

Table 5. Characteristics of the 54 Subjects Followed Up From 2002

Variables	No. (%)
Age (at baseline)	
Range	5-11
Mean ± SD	7.69 ± 1.54
Present Age	
Range	9 to 17
Mean ± SD	12.6 ± 1.43
Gender	
Male	49 (91.2)
Female	5 (8.8)
Race	
Chinese	48 (88.9)
Malay	3 (5.6)
Indian	2 (3.7)
Others	1 (1.9)
ADHD subtype	
Combined subtype	40 (74.1)
Inattentive subtype	14 (25.9)
Hyperactive-impulsive subtype	0
Ever prescribed medication	
Yes	41 (75.9)
No	31 (24.1)
Presently on medication	
Yes	12 (22.2)
No	42 (77.8)
Duration of treatment (mo)	
Range	1 to 60
Mean	32.8 ± 22.8
Presently on follow-up at CGC	
Yes	23 (42.6)
No	31 (57.4)

ADHD: attention deficit hyperactivity disorder; CGC: Child Guidance Clinic; SD: standard deviation

complained of insomnia during treatment with methylphenidate. One had improved by the following consultation, without any medication or dose change. The other experienced insomnia over a 3-week period after about 3 years of treatment with methylphenidate. Similarly, the problem resolved at review the following month without any dosage adjustment. The third patient who complained of daytime sedation did not return for the subsequent follow-up appointment.

All 41 (75.9%) patients who were treated with medication were asked about medication-related side effects during the clinical interview. This was an open-ended question to avoid providing any bias towards increased reporting of any particular side effect. Twenty-four (44.4%) reported that they had experienced side effects with the medication used to treat ADHD. Seven (13.0%) reported that medication made the children sleepy during the day, whereas 1 (1.9%) reported experiencing insomnia. There were no other sleep-related complaints reported.

The chart review and clinical interview results were compared. There was only 1 patient who appeared in both groups. Combining the results, there were a total of 10 (18.5%) patients who experienced sleep disturbance during treatment, and daytime somnolence was the common complaint. These results are summarised in Table 6.

Discussion

Our study showed significant difference in the prevalence of sleep complaints evaluated through the CBCL between patients with and without ADHD who attended our clinic. The ADHD subjects' parents were more likely to report that their children slept less. The mean summation score of the 6 sleep-related problem items was also higher in the ADHD group, which could suggest that the ADHD subjects had either greater number of sleep-related complaints or greater severity of any reported sleep problem. When the patients in the ADHD group were further compared by gender, females were found to have more frequent parental complaints of "trouble sleeping" (item 100 of the CBCL), with an odds ratio (OR) of 3.36 [confidence interval (CI) 1.30-10.00]. There was no statistical significance between males and females for the other sleep complaints or total sleep problem scores. ADHD children have been known to display difficult behaviour around bedtime. Adult females with ADHD have also reported more sleep problems.[31] One possible reason for our finding could be explained by parental expectations. Parents may expect girls to display fewer problems when it comes to bedtime and be less tolerant of minor difficulties. As for gender effects on sleep independent of ADHD, several studies have not found girls to experience more sleep problems than boys.[32-34] Further research may help to define the nature of the "trouble sleeping".

A significant proportion of the patients experienced sleep-related complaints after medication was started. Methylphenidate was the most commonly prescribed medication to treat ADHD. Chart reviews picked up 2 patients who had insomnia recorded as a side effect, which was related to methylphenidate use. Indeed insomnia is one of the better-known side effects of stimulant medication, and it is common practice in our clinic to avoid late evening doses, although some small studies have shown that even late afternoon administration of methylphenidate did not cause significant effects on sleep, save possibly for slightly reduced total sleep time.[35,36] Given the more prevalent

Table 6. Summary of Medication Received by Patients Who Experienced Sleep Disturbance

Patient no.	Complaint	All medications ever prescribed at CGC
1	Insomnia	Methylphenidate
2.	Insomnia	Methylphenidate
3.	Insomnia	Methylphenidate
4.	Daytime somnolence	Methylphenidate
5.	Daytime somnolence	Methylphenidate
6.	Daytime somnolence	Methylphenidate
7.	Daytime somnolence	Imipramine, Methylphenidate
8.	Daytime somnolence	Methylphenidate, Concerta®*, Ritalin LA®*
9.	Daytime somnolence	Methylphenidate, Fluoxetine, Imipramine, Concerta®
10.	Daytime somnolence	Methylphenidate, Atomoxetine, Ritalin LA®, Fluoxetine

* Both are extended-release preparations of methylphenidate. Ritalin LA® comes in capsules, and Concerta® is a preparation using the OROS® delivery system

appearance of sleep problems associated with medication, clinicians will need to be mindful of the need to assess for medication-related sleep problems.

The CBCL is a comprehensive questionnaire that obtains information on a wide range of emotional and behavioural symptoms. It is a useful screening tool, which is also used in many studies researching on child and adolescent psychiatric conditions. For the assessment of sleep problems, it picks up several fairly common sleep complaints, and has been used to assess sleep problems in research.[37] Unfortunately, it does not assess for conditions like sleep apnoea, sleep paralysis or restless legs syndrome.

Interestingly, when children who had received treatment were retrospectively interviewed, 14.9% complained of sleep-related problems, most of which were not recorded in the medical records. Daytime somnolence was more common than insomnia. One explanation why the complaint of sedation was not documented in the medical records for any subject was that parents might not be aware of this side effect as the child was in school. Schoolteachers might have assumed that the child was quieter due to the efficacy of the medication in controlling the hyperactive symptoms. At the same time, this is not a common problem that clinicians routinely screen for. To complicate matters, daytime somnolence is also increased in non-medicated ADHD children.[11] Many studies have found an association between excessive somnolence and ADHD as well as obesity, and it has been proposed to be the link explaining studies which have found an association between obesity and ADHD behaviours.[38] Insomnia affected 5.6% of the patients, which was slightly higher in frequency than some studies which reported a frequency of below 2%.[24] During clinic consultations, both parents and the patient should also be asked directly for the effects and side effects of treatment.

The results of our study should be interpreted with the following limitations in mind. The study samples were selected from patients who attended our clinic. Although the gender ratio of our samples were similar to most clinic-referred samples in the range of 10:1 with males being more affected, research on community samples have yielded ratios in the range of 3:1.[39,40] The ethnic make-up of our samples parallel that of the general population except the third group of ADHD subjects seen in 2002, in whom there was over-representation of the Chinese race. The sleep disturbances at baseline were only limited to those which could be picked up by the CBCL. Like many studies,[20] we relied on parental reporting of sleep disturbances, except for the third group of children whom we interviewed for treatment-related sleep effects, and this may yield different results when compared with more objective measurements like actigraphy.[41] Future studies on the same topic may consider incorporating objective measurements of the various sleep parameters for more comprehensive evaluation. When reviewing sleep-related side effects due to medication, we used chart reviews and interviews with 54 children with ADHD who were treated 4 years earlier. Such a design is prone to biases including recall, attribution and non-documentation. These biases are likely to explain the higher frequency of sleep-related side effects picked up during clinical interview compared to chart reviews. The results should thus be interpreted with caution.

Conclusion

More studies will need to be conducted to fully evaluate the wide range of sleep disturbances, which affect children with ADHD. It is important for the clinician to evaluate sleep problems before initiating treatment with medication so that treatment-related sleep complaints can be properly evaluated. While medication may also improve pre-

treatment sleep disturbances,[29] simple measures such as sleep hygiene have been shown to be effective in managing initial insomnia in ADHD children.[42]

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