

# Behavioral Problems in Children Evaluated for Sleep Disordered Breathing

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Although hyperactivity is reported to be common among children with suspected sleep disordered breathing (SDB), the spectrum of behavioral abnormalities in these children is uncertain. The aim of this study is to survey behavioral abnormalities seen in children with suspected SDB. We compared the scores from the Child Behavior Checklist of 32 suspected SDB children with those of 137 age-matched healthy children. The CBCL we used (a Japanese version of the CBCL for ages 4 through 18 years) has 113 questions that are classified into 8 categories. On this CBCL, the higher the score, the more likely is the child to have problems. We also performed one-night polysomnography on the 32 suspected SDB children and compared the SDB measures obtained from polysomnography with the CBCL scores. Suspected SDB children showed higher scores on attention, withdrawal, somatic complaints, anxiety/depression, social problems and thought problems than in the controls. However, the severity of SDB failed to significantly elevate the scales of each CBCL category. Suspected SDB children had more behavioral problems than age-matched healthy children. The spectrum of behavioral abnormalities in suspected SDB children is wider than previously recognized. The factors causing behavioral problems in suspected SDB children remain unknown. **(Sleep and Hypnosis 2003;5(2):89-94)**

**Key words:** *hyperactivity, attention deficit, sleep disordered breathing, child behavior check list (CBCL), subcortical activation, and periodic leg movement during sleep*

## INTRODUCTION

Inattention and hyperactivity are frequently seen among children with sleep-disordered breathing (SDB) (1). Adequate treatments for SDB may lead to resolution of these symptoms

(1). Sohn and Rosenfeld (2) evaluated SDB children before and after adenotonsillectomy through an 18-item health-related quality of life survey of pediatric patients with obstructive sleep apnea syndrome (3). However, they found no change in the domain of emotional distress that included mood swings or temper tantrums, aggressive or hyperactive behavior, and discipline problems. By means of the Child Behavior Checklist (CBCL) (4), Goldstein et al. (5) found that problems of anxiety/depression and thought in children with SDB were improved after tonsillectomy and/or

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adenoidectomy. However, they found no statistically significant difference in the CBCL scores on attention problems before and after the treatment (5). These facts indicate that the precise spectrum of behavioral abnormalities seen in SDB children remains uncertain. In addition, few systematic investigations have compared behavioral outcomes with polysomnographic measures of SDB. According to Chervin and Archbold (6), hyperactive behavior is also common among children with suspected SDB. However, to our knowledge, no study has been made on behavioral problems of children with suspected SDB. Therefore, the aim of this study was to survey behavioral abnormalities seen in children with suspected SDB. The CBCL, which has been translated into 33 languages (6), has been used as a standardized measure of children's behavior. Because of its wide spread use, we used CBCL in this study. Since SDB is a common disease around the world, we believe that the CBCL is a potentially useful standardized measure in conducting cross-cultural international research to survey common behavioral abnormalities seen in children suspected of having this disease.

## METHODS

### *Subjects*

The subjects of this study were 32 pediatric patients who were referred to the Pediatric Clinic of Tokyo Medical and Dental University for evaluation of SDB (M/F 24/8, age 4-9 years, mean 5.6). All of the children showed SDB secondary to adenotonsillar hypertrophy, but were free from cardiac, renal, or other diseases, and were taking no medication. A medical history was obtained and a physical examination was performed by one of the investigators. Caretakers of these children were asked to complete a Japanese version of the CBCL for ages 4 through 18 years (CBCL/4-18). As a control, the caretakers of 137 age-matched

healthy children (M/F 74/63, age 4-6 years, mean 5.3) attending public day nurseries were asked to complete the CBCL/4-18.

### *CBCL*

The CBCL/4-18 has 113 questions that are classified into 8 categories (I. Withdrawn, II. Somatic complaints, III. Anxious/depressed, IV. Social problems, V. Thought problems, VI. Attention problems, VII. Delinquent behavior, VIII. Aggressive behavior). Caretakers were asked to select one of three answers for each question (0=not true, 1=somewhat or sometimes true, 2=very true or often true). Internalizing (I+II+III), externalizing (VII+VIII), and total scales were also scored. The higher the score, the more likely it is that the child has problems in that category. Problems of inattention and hyperactivity were assessed in the category of "attention problems" on the CBCL (VI), which includes the following question: "Can't sit still, restless, or hyperactive".

### *Polysomnography*

Since the rate of periodic leg movements during sleep (PLMS) has recently been reported to show a linear association with hyperactivity among children with SDB (6), we also performed one-night polysomnography for all the suspected SDB children to assess PLMS in addition to the severity of SDB. Informed consent was obtained from the guardians of each patient, and consent was also obtained from the child if older than 5 years of age. No sedation or sleep deprivation was used and children were accompanied by a guardian throughout the night. All recordings were performed in an isolated semi-soundproof recording room with an air conditioner (temperature range, 22-24°C). Each polysomnographic session included an electroencephalograph (EEG), electro-oculograph, electromyography of the chin,

trunk and bilateral anterior tibial muscles, oxygen saturation (SaO<sub>2</sub>) monitoring (Ohmeda Biox 3740), respiratory monitoring through respiratory inductive plethysmography (RIP), and video monitoring (7,8). Neither the end-tidal nor transcutaneous level of carbon dioxide was measured. The children were continuously observed by one of the investigators and sleep stages were determined according to the standard criteria (9).

Five-minute qualitative diagnostic calibration (QDC) was performed before each RIP recording. One episode of apnea was defined as 10 seconds or more of respiratory suppression that did not exceed 25% of the baseline tidal volume determined during QDC (10). Hypopnea was defined on RIP as a series of breaths that were less than 50% and greater than 25% of the baseline tidal volume (10). According to movements of the chest and

abdominal portions during the respiratory suppression, a pause on RIP was interpreted as being obstructive or central. As in the study by Marcus et al. (11), we did not count central apnea following movement. We calculated three SDB measurements; the desaturation time (the percentage of the time with SaO<sub>2</sub><90% against the total sleep time), the SaO<sub>2</sub> nadir and the apnea-hypopnea index (AHI; incidence of obstructive apnea and hypopnea per hour of total sleep time).

## RESULTS

The mean scores on all eleven scales calculated were higher in suspected SDB children than in controls (Table 1). Statistically significant differences were obtained on the scales of withdrawn, somatic complaints, anxious/depressed, social problems, thought

**Table 1. Comparison of the CBCL scores between suspected SDB children and controls**

	Suspected SDB children (mean, SE)	Control (mean, SE)	p
Category I, withdrawn	1.9±0.3	1.0±0.1	0.002>
Category II, somatic complaints	1.0±0.2	0.3±0.04	0.0001
Category III, anxious/depressed	4.5±0.6	2.7±0.2	0.0002
Category IV, social problems	3.3±0.4	2.2±0.2	0.01
Category V, thought problems	0.9±0.2	0.3± 0.07	0.001
Category VI, attention problems	5.0±0.5	3.4±0.3	0.01
Category VII, delinquent behavior	1.4±0.2	1.1±0.1	0.26
Category VIII, aggressive behavior	7.4±0.8	5.8±0.4	0.11
Internalizing, I+II+III	7.3±0.8	3.9±0.3	0.0001
Externalizing, VII+VIII	8.8±1.0	6.9±0.5	0.12
Total	30.8± 2.5	19.7±1.4	0.0005

**Table 2. Correlation coefficients between three SDB measurements and eleven scales for the CBCL**

	Desaturation time (%)	Minimum oxygen saturation (%)	Apnea-hypopnea index (/hr)
Category I, withdrawn	-0.30	0.45	-0.40
Category II, somatic complaints	-0.09	0.22	-0.16
Category III, anxious/depressed	-0.06	0.16	-0.07
Category IV, social problems	-0.21	0.16	-0.15
Category V, thought problems	-0.04	-0.03	0.16
Category VI, attention problems	-0.32	0.24	-0.23
Category VII, delinquent behavior	0.07	-0.05	0.08
Category VIII, aggressive behavior	0.03	-0.04	0.20
Internalizing, I+II+III	-0.16	0.32	-0.22
Externalizing, VII+VIII	0.04	-0.05	0.19
Total	-0.09	0.12	0.002

problems, attention problems, internalizing, and the total scales. No PLMS was observed in all the examined children with suspected SDB.

Among the thirty-three pairs of correlation coefficients examined (between three SDB measures and eleven scales for the CBCL) (Table 2), a significant correlation was obtained between category I (withdrawn) and the SaO<sub>2</sub> nadir ( $r=0.45$ ) and the AHI ( $r=-0.40$ ). This meant that an elevation of the scale of category I was correlated with an elevation of the SaO<sub>2</sub> nadir and a decrease in the AHI. Since the severity of SDB was expressed by a decrease in the SaO<sub>2</sub> nadir and an increase in the AHI, it appears that no CBCL scale was elevated significantly in relation to the severity of SDB.

Desaturation time clearly divided our suspected SDB children into two groups. One group contained twenty-three children whose desaturation time was less than 1.0, and the other group contained nine children whose desaturation time exceeded 5.0. The mean scores on all of the eleven scales calculated for suspected SDB children were higher in children with desaturation times of less than 1.0 than they were in the children with desaturation times of 5.0 or more (Table 3). This supports the data on the correlation coefficient between SDB measurements and the CBCL scales.

## DISCUSSION

Our results indicated that suspected SDB children had more behavioral problems than age-matched healthy children. Children with suspected SDB had problems associated with not only the categories of inattention and hyperactivity but also a variety of other categories (withdrawn, somatic complaints, anxious/depressed, social problems, and thought problems). Chervin and Archbold (6) conducted systematic studies on behavioral problems related to the severity of SDB, and found that hyperactivity had no significant relationship to the rates of apneas, minimum oxygen saturation, or most negative esophageal pressures in children with suspected SDB. In agreement with this observation, our current study showed that no CBCL scale was elevated significantly in relation to the severity of SDB.

Chervin and Archbold (6) also demonstrated that levels of hyperactivity were associated with the presence of PLMS. Contrarily to their report (6), we found no PLMS among children with suspected SDB. In general, hypoxia and disrupted sleep patterns, including those caused by PLMS, have been considered integral to the development of neurocognitive and behavioral problems in SDB children (5,6). This hypothesis

**Table 3. Comparison of the CBCL scores between mild and severe SDB children**

Desaturation time	5.0 or more	Less than 1.0	Significance
Gender (M/F)	6/3	18/5	ns*
Age (yrs)	5.2±0.4	5.9±0.4	ns
Apnea-hypopnea index (/hr)	19.4±4.2	0.5±0.2	p<0.001
Minimum oxygen saturation (%)	65.0±4.8	88.6±0.6	p<0.001
Desaturation time (%)	15.1±2.9	0.3±0.1	p<0.001
Category I, withdrawn	0.78±0.36	2.30±0.34	p<0.05
Category II, somatic complaints	0.67±0.29	1.13±0.19	ns
Category III, anxious/depressed	3.67±1.05	4.87±0.69	ns
Category IV, social problems	2.44±0.41	3.61±0.53	ns
Category V, thought problems	0.78±0.43	0.96±0.23	ns
Category VI, attention problems	3.44±0.87	5.61±0.53	p<0.05
Category VII, delinquent behavior	1.33±0.47	1.48±0.21	ns
Category VIII, aggressive behavior	7.11±2.04	7.48±0.85	ns
Internalizing, I+II+III	5.11±1.38	8.13±0.87	0.05<p<0.1
Externalizing, VII+VIII	8.44±2.42	8.96±0.98	ns
Total	26.67±5.86	32.74±2.53	ns

ns: non significant

is supported by Gozal who reported that overall school performance was significantly improved one year later in children undergoing surgical removal of hypertrophic adenotonsillar tissue causing obstructive sleep apnea syndrome (12). Based on this observation, Lipton and Gozal mentioned that SDB may impose adverse and sustained neurocognitive outcomes and diminished academic achievement, particularly when SDB develops during critical phases of brain growth and development (13). According to this notion, the severity of SDB is likely to correlate with the high scores on the CBCL. The current results, however, do not support this hypothesis. The factors responsible for behavioral problems in suspected SDB children as well as in diagnosed SDB children remain to be determined.

In adults, excessive daytime sleepiness and neurobehavioral abnormalities of vigilance and reaction time are the sequelae of frequent arousals caused by SDB (14). Similar to adults,

children with SDB have been reported to have neurobehavioral sequelae, but excessive daytime sleepiness is less common in SDB children than in adult patients (15). This may be due to the fact that SDB does not result in cortical arousal in children (16). However, more subtle alterations in the spectral characteristics of the electroencephalogram or arousals at subcortical levels do occur during SDB in children. We recently proposed that a sigh associated with elevated chin muscle activity lasting less than 10 seconds could be a sensitive and useful index for assessing subcortical activation (17). However, so far, no consistent measures reflecting subcortical arousals are available. In the present study, we did not assess arousal response including electroencephalographic changes, the duration of SDB or the age of onset of SDB. These observations would be needed to elucidate the cause of neurocognitive and behavioral problems in suspected SDB children.

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