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ORIGINAL ARTICLE

Sleep-disordered breathing, behavior, and academic performance in Taiwan schoolchildren

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Abstract
Objective The behaviors of children may be affected by sleep-disordered breathing (SDB). This study adopts a cross-sectional approach to investigate the relationship between the sleep apneas–hypopneas index during sleep and the behavioral and academic performance of schoolchildren in Taiwan.
Methods A total of 138 children (85 boys and 53 girls), ages 6–11, were recruited from two elementary schools to participate in this study. Overnight polysomnographic examinations in hospital were performed to assess sleep quality, including total sleep time, arousal index, apneas–hypopneas index, desaturation index, and lowest oxygen saturation, as well as the percentage of total sleep time spent in rapid eye movement, stage 1, stage 2, stage 3, and stage 4. The children's parents and teachers were required to complete a Chinese version of the Child Behavior Checklist and Teacher's Report Form to assess child behavior and academic achievement.
Results Compared with children without SDB (apneas–hypopneas index ≤1), those with severe SDB (apneas–hypopneas index >15) exhibited more irregular behavioral performance in somatic complaints (odds ratio (OR)=9.43; 95% confidence interval (CI)=1.04–85.71) and attention (OR=9.95; 95% CI=1.02–97.00). However, different severities of SDB groups did not show significant associations in academic performance.
Conclusion Our study suggests that children with severe SDB may predispose to somatic complaints and attention problems so that sleep examination or medical intervention might be provided at an early age in these children.

Keywords Sleep-disordered breathing · Polysomnography · Children behavior · Academic performance

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Introduction

Sleep-disordered breathing (SDB) in children has been characterized by intermittent partial or complete upper airway obstruction during normal sleep patterns [1]. SDB may have different prevalence and risk factors in different ages, communities, and ethnic groups. The prevalence varies from 0.7% to 3.0% in children [2–5]. Importantly, children in Taiwan should theoretically have more SDB than those in other geographical locations because of the typical narrowing of craniofacial features [6]. Especially in subtropical area like Taiwan, children usually live with a hot, humid climate with concomitant industrialized and urbanized environments. Thus, associated environmental factors (e.g., air pollution) could accelerate the hypertrophy of the inferior nasal conches causing nasal obstruction [7].

The behaviors of children may be affected by SDB, such as snoring or obstructive sleep apnea. For example, abnormal behaviors have been linked to sleep disorders such as somatic complaints [8], attention disorders [9–11], aggressive behaviors [8, 11], oppositional behaviors [8, 11], hyperactivity disorder [8–10], problems of socialization [8, 11], and cognition [11]. Children suffering from SDB may also receive unsatisfactory grades in school [12–14]. Previous findings suggested that children with SDB over the crucial period of brain growth for developing cognitive and intellectual capabilities may suffer from a partially irreversible compromise of their a priori potentials for academic achievement [13, 14]. However, the precise mechanisms responsible for neurocognitive impairments in children with SDB are not quite clear.

In Taiwan, most of children's abnormal psychological or physiologic problems caused by SDB have failed to attract public attention. Typically, both schools teachers and parents always overemphasize superior academic performance on their students and children in Taiwan [15]. However, Taiwan society did not recognize that children suffering SDB who need to be helped is an issue. Our study focuses on exploring whether the relationship among children in Taiwan with SDB, behavior, and their academic performance.

Materials and methods

Subjects

Primary education in Taiwan lasts for 6 years; school age is from 6 to 12 years old. The primary schools are divided into six grades, each of which contains one age group. Our current study began with an SDB educational campaign. Physicians and educators went to two elementary schools in Taichung, a city in central Taiwan, to promote recognition of SDB and potential health risks of SDB in children based on the theory of the health belief model [16, 17]. These two schools were selected by random sampling from 68 schools in Taichung. All of the students in grades higher than second grade were enrolled. Seminars were held for school teachers and parents. Pamphlets were distributed to parents via children. Furthermore, this SDB educational campaign offered a free polysomnography (PSG) examination. A total of 138 participants (85 boys and 53 girls) from 1,836 students were recruited on a volunteer basis in this study. Parents brought their children to our hospital for PSG examinations might be that these parents had a heightened awareness of the health threat of SDB on their children. Informed written consent was obtained from the children's parents.

Design and timing of study events

After our SDB educational campaign, parents of children who were above the second grade in these two schools filled out the Chinese version of the Child Behavior Checklist (CBCL), which recorded child behavior performance information during the weekdays. At that time, parents could freely decide whether or not their children should undergo an overnight PSG examination. Their parents would then tell our staff to arrange this examination. Tested children attended their follow-up appointments in succession at the sleep center of Chung Shan Medical University Hospital for overnight PSG examinations. Children were not absent from school for this PSG examination due to the fact that they attended PSG examinations during the night between 8:00 p.m. and 6:00 a.m. the next morning. Following the examination, parents and children were told to come back for an SDB physician outpatient for their PSG results and diagnosis. An SDB physician in the hospital would inform parents and children of their PSG results and SDB diagnosis and refer children with sleep disorders for treatment. School teachers remained unaware of students who had attended PSG examinations. Teachers in these two schools also completed Teacher's Report Forms (TRF) for all children in or above the second grade at the end of the semester. Our PSG analysts were blind to the children's CBCL and TRF status.

Anthropometric measurement and polysomnographic examination

Before PSG examination, physicians gave children check-ups to exclude those who had symptoms, including common cold, allergic rhinitis, and asthma. All children were requested to arrive at our sleep laboratory between 8:00 p.m. and 9:00 p.m. All recordings started at 10:00 p.m. and ended at 6:00 a.m. the next morning. A family member was allowed to accompany the children during the PSG process. A well-trained sleep laboratory technician set up and monitored each recording. The assessments of anthropometric parameters were performed in all children with loose-fitting clothing. Body weight and height were measured by an electronically calibrated scale and a calibrated stadiometer, respectively. Neck, waist, and hip circumferences were measured in the standing position by calibrated plastic tapes. Body mass index (BMI) was calculated as weight divided by height squared (kilogram per square meter). A 12-channel polysomnographic recording system (Rembrandt, Medcare Diagnostics, Amsterdam, Netherlands) was used in this study to measure sleep, respiratory, and cardiac status. The recordings of electroencephalography (C3/A2, C4/A1), electrooculography, and submental electromyography as well as oxyhemoglobin saturation (pulse oximetry), nasal airflow, nasal pressure, rib cage, and abdominal motion were measured to assess sleep state and episodes of SDB, according to standard criteria [18].

In our study, sleep polysomnographic parameters included total sleep time (TST), arousal index (AI), apneas–hypopneas index (AHI), desaturation index (DI), and lowest oxygen saturation (LOS %), as well as the percentage of TST spent in rapid eye movement (REM), stage 1, stage 2, stage 3, and stage 4. Central apneas were defined by the absence of tidal volume excursion for at least 5 s accompanied by an absence of rib cage and abdominal movements. Central hypopneas were defined as a 50% or greater reduction in tidal volume from the baseline value, without paradoxical chest wall motion, persisting for at least 5 s. Obstructive apneas and hypopneas were defined similarly, except that paradoxical motion of rib cage and abdomen had to be present during the event. In our study, total AHI was included central and obstructive apneas and hypopneas. The AHI was defined as the number of apneas and hypopneas per hour of sleep. Both apnea and hypopnea were given equal weight in judging the severity of SDB [19]. In addition, DI was defined as the number of oxygen desaturations at least 4% per hour of TST. Arousals were classified as either one of two types: respiratory-related or spontaneous arousals. Respiratory arousals were those occurring during or immediately after an apnea or hypopnea associated with desaturation. A spontaneous arousal was not associated with a respiratory event. Arousals that occurred in response to noise or other external stimuli were not included. An arousal index, expressed as the number of arousals per hour, was calculated for both respiratory and spontaneous arousals according to apnea type [19].

Although SDB occurs in the pediatric population, diagnostic criteria have not been well established. Furthermore, the severity of SDB was classified on the basis of AHI by a modification of the criteria developed by American Academy of Sleep Medicine [1], with non-SDB being AHI≤1, mild SDB being1<AHI≤5, moderate SDB being 5<AHI≤5, and severe being AHI>15 as in previous studies [20–22].

Instruments and measures

Information about the children's grade, gender, prematurity at birth, and the parent's education status was obtained through a questionnaire for parents. The Chinese version of the CBCL and TRF were also used in our study. Their validity and reliability have already been established [23, 24]. Parents were responsible for filling in the CBCL form. The CBCL is a widely used questionnaire designed to assess the behavioral problems and social competence of children 4 to 18 years of age [25]. The CBCL/4-18 comprises 20 competence items and 118 behavioral/emotional items. This checklist questionnaire was divided into eight behavioral aspects: withdrawal, anxiety and depression, somatic complaints, social problems, thought problems, attention problems, delinquent behaviors, and aggressive behaviors. They were grouped into two broadband scores: internalization behavior problem score, consisting of withdrawal, anxiety and depression, and somatic complaints; and externalization behavior problem score, consisting of delinquent and aggressive behaviors. Standardized T scores with a mean of 50 (standard deviation (SD)=10)) were provided for each subscale. The higher the T score, the more severe the children's behavioral and psychological problems [24]. In addition, teacher filled out the TRF. Teachers rated their students on academic performance, adaptive functioning, and behavioral/emotional problems using a five-point scale (with 1 being the lowest and 5 being the highest) [26]. In this study, we measured child academic performance on the subjects of Chinese, English, mathematics, society, nature and science technology, and arts and humanities. Similar to CBCL, the lower the T score was, the more impaired the child's academic performance was.

Statistical analysis

Demographic data and sleep-related variables by PSG examination were expressed as means (± SD) and frequencies. The data for demographic characteristics, sleep parameters, behavioral performance, and academic achievements were compared among the four groups; non-SDB (AHI≤1), mild SDB (1<AHI≤5), moderate SDB (5<AHI≤15), and severe SDB (AHI>15), using a one-way analysis of variance (ANOVA) with Tukey's post hoc comparisons. The non-SDB (AHI≤1) group served as a reference. Variables were evaluated for potentially confounding factors such as age, sex, BMI, parental education, and premature to compare their distributions in different AHI groups. In further statistical analysis, logistic regression was used to adjust potential confounding factors. Adjusted odd ratios (ORs) and a 95% confidence interval (95% CI) on child behavioral performance were evaluated for the severity of SDB by different AHI groups using a multiple logistic regression model.

Results

Demographic characteristics and sleep parameters in polysomnographic examination of study children are given in

Table 1. The mean age of children was 10.2 (SD=1.0; range: 9–12). BMI was significantly different in children between AHI≤1and AHI>15 group (P=0.046) by ANOVA with Tukey's post hoc analyses. However, age (P=0.14), gender (P=0.51, χ^2 test), maternal education (P=0.60), paternal education (P=0.52), and premature (P=0.47) did not significantly differ among the different AHI groups by ANOVA. Subsequently, sleep conditions for children were also compared by different AHI groups. A significant difference in total AI among different AHI groups was found. Children with greater AHI had a higher total AI index, especially respiratory arousal index. In addition, DI scores and LOS were significantly different in children among different AHI groups. Children in AHI>15 group had the highest DI scores and lowest LOS. Other sleep polysomnographic parameters including TST, sleep efficiency, sleep latency, REM latency, and the percentage of TST spent in REM, stage 1, stage 2, stage 3, and stage 4 were not found to be significantly different among four AHI groups.

We examined the differences in child behavior performance for these four AHI groups with ANOVA, as shown in Table 2. Children with the severest (AHI>15) received worse behavior performance scores on all eight tests in CBCL than did children in other AHI groups. Of special note were significant differences on the performance scores of somatic complaints (P=0.035) and attention problems (P=0.031) which were observed between AHI≤1 group and AHI>15 group. Since T scores of the subscale in CBCL≥60 were suggested as a measure of irregular behavior [26], the discrepancy in different AHI groups was further detected.

Table 1 Demographic characteristics and sleep parameters in polysomnographic examination of study children by different AHI groups

	AHI≤1 (N=10)	1<AHI≤5 (N=21)	5<AHI≤15 (N=80)	AHI>15 (N=27)
Age (years)	10.1±0.9	10.1±1.2	10.1±1.0	10.6±1.0
Sex				
Male	4 (40.0%)	13 (61.9%)	50 (62.5%)	18 (66.7%)
Female	6 (60.0%)	8 (38.1%)	30 (37.5%)	9 (33.3%)
Body mass index	17.1±0.8	18.8±2.9	17.8±2.9	19.8±4.5**
Maternal education attainment				
≥16 years	1 (10.0%)	0 (0%)	8 (10.0%)	2 (7.4%)
12 years	6 (60.0%)	10 (47.6%)	46 (57.5%)	14 (51.9%)
≤9 years	3 (30.0%)	11 (52.4%)	26 (32.5%)	11 (40.7%)
Paternal education attainment				
≥16 years	2 (20.0%)	2 (9.5%)	7 (8.8%)	3 (11.1%)
12 years	5 (50.0%)	7 (33.3%)	44 (55.0%)	15 (55.6%)
≤9 years	3 (30.0%)	12 (57.2%)	29 (36.2%)	9 (33.3%)
Premature	0 (0%)	0 (0%)	6 (7.5%)	2 (7.4%)
Total sleep time (min)	322.8±11.9	325.2±14.4	323.3±19.1	330.9±11.9
Sleep efficiency (%)	90.1±4.7	91.2±5.2	90.8±4.7	92.6±3.6
Sleep latency (min)	12.3±8.4	12.1±7.5	12.5±8.7	11.9±8.8
REM latency (min)	140.9±54.8	153.0±52.2	147.4±50.1	141.5±64.0
REM (%)	11.5±3.9	15.3±5.7	14.2±6.1	16.2±5.5
Stage 1 (%)	1.4±0.8	1.8±1.4	1.9±1.7	1.7±1.5
Stage 2 (%)	53.7±13.3	51.2±12.7	53.9±12.8	56.9±14.0
Stage 3/4 (%)	24.4±12.0	26.9±12.6	22.6±10.9	18.3±13.0
Spontaneous AI (h)	11.1±2.5	12.0±5.1	11.2±5.3	10.6±7.7
Respiratory AI (h)	0.4±0.3	1.0±0.5	2.7±1.8*	5.7±4.2*
Total AI (h)	11.03±2.5	13.5±4.6	14.5±5.2	17.6±8.6***
DI (events/h)	0.7±0.4	2.4±1.7	1.5±1.5	3.6±2.9*
LOS (%)	92.1±3.0	90.1±3.0	91.8±2.8	88.5±3.0****

Comparison among different AHI groups are conducted with ANOVA with Tukey's post hoc analyses.

REM rapid eye movement sleep, *AHI* apnea–hypopnea index, *DI* desaturation index, *AI* arousal index, *LOS* lowest oxygen saturation

*P<0.001 (significant differences from AHI≤1 group); **P=0.046 (compared with body mass index significant differences from AHI≤1group); ***P=0.05 (compared with total AI (hour) significant differences from AHI≤1 group); ****P=0.006 (compared with LOS (percentage) significant differences from AHI≤1 group)

Table 2 Comparison of child behavior performance in CBCL by different AHI groups

	AHI≤1 (*N*=10)	1<AHI≤5 (*N*=21)	5<AHI≤15 (*N*=80)	AHI>15 (*N*=27)
Withdrawal	52.4±10.7	52.4±7.6	50.5±8.5	55.5±10.6
Somatic complaints	47.7±6.9	53.6±8.7	53.0±10.6	59.5±10.9*
Anxiety and depression	49.8±5.0	50.1±7.2	52.1±10.8	57.0±10.2
Social complaints	49.1±5.5	55.2±10.6	51.2±10.0	56.1±11.0
Thought problems	51.4±8.9	52.7±9.7	52.3±9.4	54.1±8.4
Attention problems	47.0±5.8	52.6±7.9	52.3±10.5	58.0±11.9**
Delinquent behaviors	55.5±18.2	52.3±11.1	52.3±9.8	52.3±7.1
Aggressive behaviors	48.3±6.7	53.8±9.6	52.1±9.2	54.7±9.9
Internalization behavior problems	50.6±8.1	53.4±8.5	53.4±11.1	58.6±10.1
Externalization behavior problems	49.2±8.8	53.7±9.8	52.7±9.9	54.0±9.2

Comparison among different AHI groups was conducted with ANOVA with Tukey's post hoc analyses.

CBCL Child Behavior Checklist, *AHI* apnea–hypopnea index

*P=0.035 (compared with somatic complaints significant differences from AHI≤1 group); **P=0.031; compared with attention problems significant differences from AHI≤1 group

The adjusted associations of somatic complaints and attention problems in different AHI status were shown in Table 3. Because BMI was significantly different in children with different AHI groups (Table 1), the BMI effect was further adjusted in our multiple logistic regression. Compared to children with non-SDB, children with mild SDB, moderate SDB, and severe SDB had higher risk of developing somatic complaints and attention problems. Especially, significantly elevated risks were observed in children with severe SDB (somatic complaints: OR=9.43; 95% CI=1.04–85.71; attention problems: OR=9.95; 95% CI=1.02–97.00). Children with severe SDB had significant risks of somatic complaints and attention problems when compared to those with moderate SDB (somatic complaints: OR=2.88; 95% CI=1.13–7.33; attention problems: OR=3.21; 95% CI=1.18–8.76). However, significantly higher risks of developing somatic complaints and attention problems were not found in children with moderate SDB compared to those with mild SDB. No significant differences were found in academic performance in the subjects of Chinese, English, mathematics, society, nature and science technology, and arts and humanities among four AHI groups (Table 4).

Discussion

In current study, children in the severe AHI group had a greater BMI than those in other AHI groups. Previous

Table 3 Adjusted associations of somatic complains, attention problem, and child's AHI status

	AHI≤1 (*N*=10)	1<AHI≤5 (*N*=21)	5<AHI≤15 (*N*=80)	AHI>15 (*N*=27)
Somatic complaints				
≥60 (*N*)/<60 (*N*)	1/9	6/15	22/58	14/13
OR (95% CI)	Reference	2.82 (0.26–30.85)	3.35 (0.40–28.09)	9.43 (1.04–85.71)*
		Reference	1.00 (0.34–2.93)	2.08 (0.60–7.23)
			Reference	2.88 (1.13–7.33)**
Attention problems				
≥60 (*N*)/<60 (*N*)	1/9	5/16	18/62	13/14
OR (95% CI)	Reference	1.76 (0.16–19.95)	2.62 (0.31–22.12)	9.95 (1.02–97.00)***
		Reference	1.12 (0.99–1.23)	1.09 (0.96–1.24)
			Reference	3.21 (1.18–8.76)****

Comparisons were conducted with multiple logistic regression and adjusted the effect of BMI.

AHI apnea–hypopnea index

*P=0.046 (compared with AHI≤1vs AHI>15 in the somatic complaints); **P=0.027 (compared with 5<AHI≤15 vs AHI>15 in the somatic complaints); ***P=0.048 (compared with AHI≤1vs AHI>15 in the attention problems); ****P=0.023; compared with 5<AHI≤15 vs AHI>15 in the attention problems

Table 4 Comparison of academic achievement in Teacher's Report Form by different AHI groups

	AHI≤1 (*N*=10)	1<AHI≤5 (*N*=21)	5<AHI≤15 (*N*=80)	AHI>15 (*N*=27)
Chinese	51.5±11.0	50.0±10.4	49.5±8.6	50.9±7.7
English	54.4±10.7	50.2±10.7	49.7±9.7	51.7±10.5
Mathematics	54.5±4.4	50.2±10.3	50.9±7.9	50.9±9.5
Society	53.7±7.9	50.1±10.5	51.2±8.4	52.0±7.7
Nature and science technology	52.2±8.6	51.3±9.6	50.5±10.1	49.4±6.6
Arts and humanities	51.3±9.2	51.1±10.1	50.4±8.5	48.2±6.5

Comparisons were conducted with ANOVA among different AHI groups.

AHI apnea–hypopnea index

studies have indicated that childhood obesity was associated with SDB [27, 28]. Several hypotheses also have been proposed for explaining why obese children are at risk of SDB, including reduction of the intrathoracic volume causing lower oxygen reserves [29], impaired ventilatory responses to hypoxia and hypercapnia, hypoventilation because of leptin resistance [30], and central apnea followed by narrowing or collapse of the upper airway [31]. In practice, an important concern is that obese children may have adenotonsillar hypertrophy [32, 33], which may reduce the cross-sectional diameter of the upper airway [34]. However, the effect of adenotonsillar hypertrophy was not evaluated in our study. Further study is needed to understand the role of adenotonsillar hypertrophy on SDB-induced health effect, especially obese children.

In addition, an association between increased arousal index and SDB severity was observed among our tested children, with results that were similar to previous studies [35, 36]. The differences in polysomnographic parameters observed in the current study were similar to other children research including sleep efficiency and sleep stages, although AHI classification was different [35, 36]. We also observed an oxygen deficit in children with severe SDB, AHI>15 group. It has been proposed that, when breathing pauses, oxygen is blocked before entering into the lungs [37]. Decreasing regional cerebral oxygen has been found in children with increasing SDB status and is related to mean arterial blood pressure and oxygen saturation during sleep [35]. These findings explained children with severe AHI having the highest DI values and lowest LOS.

Although abnormal behaviors have been explored in SDB children [8–11], the causal relationship between SDB and neurobehavioral performance has not been firmly established. In our study, the Chinese version of the CBCL and TRF were used to assess the behavioral problems and academic performance of children. Their validity and reliability have already been established [23, 24]. We observed that SDB severity corresponded to increased CBCL subscale behavior scores among our children. As expected, children with severe AHI displayed obvious differences in somatic complaints and attention problems when compared to other children. Previously, Rosen et al. [8] have suggested somatic complaints of children corresponded with their SDB through CBCL measurement. Zhao et al. [38] utilized different levels of respiratory disturbance indexed by PSG and CBCL in school-aged children and found an increased risk of somatic complaints associated with SDB.

Many studies have identified that the attention span of children is associated with SDB by CBCL [11, 39]. Importantly, it has been proposed that children should be assessed for symptoms of sleep disorders when considering a diagnosis of attention-deficit/hyperactivity disorder [40]. In our study, children with severe SDB also scored significantly lower than the other children with less severity on the attention domain. One possible cause was that SDB leads to decreased arterial blood oxygen saturation, and results in hypoxemia in the brain [41]. A potentially serious consequence of intermittent hypoxia during sleep might involve its long-term effects on neuronal function [42].

Aggressive behavior differences were reported between non-SDB and SDB defined by CBCL in other studies which were conducted in Western countries [8, 11]. However, we did not find significant differences in aggressive behaviors among children who experienced different SDB status. This discrepancy might be explained by conservative behaviors of children in Taiwan compared to the children in Western society. Even when suffering somatic pain, children in Taiwan often suppress their tempers and do not attack their peers. Other than aggression, social problems were also mentioned among SDB children in previous Western studies with CBCL [8, 11]. We also did not find differences in social problems among our tested children with a different SDB status. Traditionally, children are more reliant on their parents and families in Chinese society. This gap in parental reliance between Western and Eastern cultures might explain the discrepancies between this study and other researches. The difference in rearing children between Western and Eastern society has also been indicated; Western mothers underlined the importance of letting the child develop his or her abilities as an individual, and Chinese mothers valued filial piety, respectfulness, proper demeanor, and obedience [43]. This cultural dissimilarity may help us to realize the result difference from other Western studies in aggressive behaviors and social problems through measured CBCL.

In previous studies, SDB in children was suggested to influence their school performance [12–14]. However, despite potentially irregular behavior, children with SDB in our study were not affected by their SDB situation in areas of academic performance. We observed that performance of SDB children in individual school subjects was the same as other normal children. This could be explained by the strong academic emphasis in Taiwan and that parents have higher academic expectations of their children and emphasize their school performance over everything else [15]. It is quite common for parents to employ tutors or send children to "cram" schools to help the students become familiar with more extensive lessons and thus gain an academic edge on their peers. This may allow them to keep up even when sleep deprived. Thus, we did not find any differences in academic performance on our subjects of Chinese, English, mathematics, society, nature and science technology, and arts and humanities among children with a different SDB status. However, the sample size was too small to detect difference in academic performance between children with different SDB status might be another reason. In addition, our cross-sectional study design might also be a reason that we failed to determine whether SDB children preceded poor academic performance. Therefore, establishing a time sequence would be critical for demonstrating causality.

There were several limitations in this study. The parents of the children could freely decide whether or not their children should undergo an overnight PSG examination. Children who had not a threat of SDB would not tend to have a PSG examination. This might cause the sample size of our control group (AHI≤1) to be too small. In addition, we did not assess sleep duration issue in our study, because tested children would be on beds in a hospital at 10:00 p.m. and ended at 6:00 a.m. the next morning for a PSG examination. Our results may have been subject to biases inherent in surveys. Because our children are recruited from school populations via our SDB educational campaign, this may have led to oversampled children with SDB and/or behavior problems by their parent's perception. It is important to note the parental perceptions of children with SDB (like snoring), and behavior symptoms usually depend on the presence of a family member within the home and could be affected by personal, social, and cultural differences.

In this study, we observed that children with severe SDB may predispose to somatic complaints and attention problems so that sleep examination or medical intervention might be provided at an early age in these children.

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Conflict of interest statement None of the authors have a conflict of interest involved in the study.

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