REVISTA CHILENA DE PEDIATRÍA
www.revistachilenadepediatria.cl
www.scielo.cl

Rev Chil Pediatr. 2020;91(2):239-245
DOI: 10.32641/rchped.v91i2.1282

ORIGINAL ARTICLE

Relationship between body composition and sleep-disordered breathing in schoolchildren from Valdivia, Chile

Composición corporal y trastornos respiratorios del sueño en escolares de Valdivia, Chile

Valentina Da Bove[a], Claudia Papamichail[b], Romina Vera[b], Ivonne Santibáñez[b], Pablo Castillo[a], R. Mauricio Barría[a]

[a]Kinesiology Unit, Faculty of Medicine, Universidad Austral de Chile, Valdivia, Chile
[b]School of Kinesiology, Faculty of Medicine, Universidad Austral de Chile, Valdivia, Chile

Received: 12-6-2019; Approved: 1-12-2019

What do we know about the subject matter of this study?

Sleep-disordered breathing (SDB) is related to overnutrition, especially to body mass index (BMI), and is associated with poor school performance in schoolchildren.

What does this study contribute to what is already known?

This study proposes the detection of SDB through a cost-effective questionnaire that shows the disorder prevalence. Locally, it was determined that SDB is related to the bicipital and tricipital skinfolds, but not to BMI.

Abstract

Overnutrition in childhood constitutes a global epidemic and has been associated with multiple diseases and complications. Among them, sleep-disordered breathing (SDB) stands out, a spectrum of diseases that have emerged as a relevant health problem. **Objective:** To evaluate the association between nutritional status and SDB in schoolchildren. **Subjects and Method:** Cross-sectional analytical study of 127 schoolchildren randomly selected from five public schools in Valdivia, Chile. After the informed assent and informed consent process of the child and parents/guardian respectively, the students were incorporated into the study. Anthropometric measurements were performed and the presence of SDB was determined through the Pediatric Sleep Questionnaire (PSQ). For the data analysis, the t-test and χ^2 test were used to determine the association of variables with SDB. **Results:** There was a high prevalence of overnutrition (71.7%) and obesity reached 39.4%. Regarding the prevalence of SDB, it was 32.3%. There was a higher proportion of children with SDB in severely obese schoolchildren (56.3%), as well as, a significantly higher mean of biceps and triceps skinfold thickness in children with SDB (14.6 mm ± 7.3 vs. 12.0 mm ± 6.6, p = 0.002, and 19.8 ± 6.7 mm vs. 16.2 mm ± 6.0, p = 0.04, respectively). **Conclusions:** There is high prevalence of overnutrition and SDB. Out of the anthropometric measurements, the presence of SDB was associated with greater thickness of the biceps and triceps skinfolds.

Keywords:
Sleep Apnea Syndromes; Obesity; School Health; Child Health; Surveys and questionnaires

Correspondence:
R. Mauricio Barría
rbarria@uach.cl

How to cite this article: Rev Chil Pediatr. 2020;91(2):239-245. DOI: 10.32641/rchped.v91i2.1282

Introduction

Sleep-disordered breathing (SDB) in children is a group of disorders with a wide spectrum of clinical presentation and severity, ranging from primary snoring to obstructive sleep apnea, with variable consequences such as daytime sleepiness or hyperactive behavior, or others such as learning difficulties and poor school performance which have a significant impact[1].

Studies on SDB have demonstrated the difficulties in its diagnosis due to different methodological problems, most of them imply heterogeneity in diagnostic accuracy. Frequencies of parent-reported SDB are described based on symptoms ranging from 4 to 11%[2]. There is a varying prevalence of SDB symptoms across countries, with high prevalence in Nigeria[3] (34%) and Brazil[4] (27.6%) and lower prevalence in Malaysia[5] (14.9%) and Germany[6] (10.1%). In the Chilean child population, the prevalence of habitual snoring is 18%, representing initial symptoms of the SDB spectrum[7].

The gold standard for SDB diagnosis is polysomnography (PSG)[8], a study that provides information on neurophysiological and cardiorespiratory parameters. This high-cost test needs to be carried out in sleep laboratories, which complicate the access to it. Therefore, to facilitate the SDB detection, low-cost and easy-to-do pediatric questionnaires have been developed. One of them is the Pediatric Sleep Questionnaire (PSQ), which includes 22 questions about the symptoms of SDB and is answered by parents or caregivers[9].

There is different evidence on the relationship between obesity, apneas and sleep architecture in school children, however, most of the results focus on the development of metabolic dysfunctions and associated morbidity[10].

The Los Ríos Region, where this study was carried out, is one of the regions with the highest rate of obesity in Chile. According to data collected in 2015, 45% of eighth-grade schoolchildren had a body mass index (BMI) that classified them as overweight (20%) or obesity (25%), figures that are gradually increasing over time[11].

In addition, this context emphasizes the development of this study in the school population since the relationship between SDB and lower academic performance has been demonstrated. Consequently, this work aimed at evaluating the relationship between body composition and the presence of SDB in schoolchildren attending first to eighth grade in a public school in Valdivia, Chile.

Subjects and Method

Design

Analytical cross-sectional observational study aimed at establishing the relationship between nutritional status and the presence of SDB. The fieldwork was carried out during December 2016. The Scientific Ethical Committee of the Health Service of Valdivia (Ord. No. 449, November 29, 2016) evaluated and approved this study and the parents and/or guardian authorized the participation of each student by signing informed consent and with the assent of them

Target and sampling population

The sample consisted of schoolchildren of both sexes, attending first to eighth grade, from five public schools in Valdivia, Chile, selected via simple random sampling. Within the educational establishments, the selection of school children was carried out through stratified random sampling with proportional affixing. Those children with neuromotor or respiratory disorders were excluded, as confirmed by medical records and parental reports (e.g., asthma).

From a total population of 2,660 schoolchildren attending public schools in the city, we calculated a representative sample of 209 students considering a 95% confidence interval, 5% of accuracy (estimation error) and 18% of expected proportion of SDB in the population. The nQuery Advisor® 7.0 software (Statistical Solutions, Saugus, Mass., USA) was used for the sample size calculation.

However, only 191 parents or guardians approved the participation, 51 potential participants did not attend on the day of the evaluation, and 13 did not answer the PSQ questionnaire, resulting in a sample of 127 schoolchildren.

Data collection technique and procedures

The assessments were conducted in each participating school. First, anthropometric measurements were recorded and then the PSQ questionnaire was applied to the child's parents or guardian.

The anthropometric variables evaluated were weight, height, biceps, triceps, supraspinale and subscapular skinfolds, as well as neck and waist circumference. BMI was calculated using the formula = weight (kg)/height (cm)^2) and was classified as underweight, normal weight, overweight and obesity/ severe obesity according to the Standard for Nutritional Assessment of the Ministry of Health of Chile[13].

The skinfolds were measured with Slim Guide Skinfold Caliper®. Body fat composition was determined using Lohman's specific formula for children by sex and age[14], for which Density (D) was previously calculated using Brook's equations for children up to

11 years of age and Durnin and Womersley's equations for 12 years of age and older[15].

In addition, the data collection included demographic information such as age, sex, and academic information such as grade and academic performance operationalized as overall grade point average (scale 1 to 7). It was not possible to collect data divided into areas or subjects.

PSQ Questionnaire

We used the PSQ sleep-related breathing disorders questionnaire (reduced version in Spanish), which is an instrument used in Chile with good diagnostic accuracy[16]. It contains 22 questions divided into three sections: A) Behavior during the night and while sleeping; B) Behavior during the day and other possible problems; C) Symptoms of attention deficit/hyperactivity disorder. The possible answers and scores for each item in sections A and B are "Yes"= 1, "No" and "Don't know"= 0. For section "C", to reduce to Yes/No answers for the items with more possible answers, "Never" and "Sometimes" were scored as "No"= 0, and "Many times" and "Almost always" were scored as "Yes"= 1. The PSQ score was calculated by adding the total count of all "Yes"/total count of all "No" and "Yes" responses. ≥ 0.33 was considered a cut-off value[16].

Statistical analysis

The data were tabulated in a Microsoft Excel 2013 spreadsheet and analyzed using Stata software v.11.2 (StataCorp LP, College Station, Texas, USA, 2009), and descriptive statistics were used to characterize the schoolchildren.

Initially, the goodness of fit for normality of the quantitative variables was evaluated by analyzing their graphic distribution (histogram) and using the Kolmogorov-Smirnov test. In this way, quantitative variables such as age, grade point average and the different anthropometric measures are described as mean and standard deviation. Qualitative variables such as sex and grade are shown as absolute and relative frequency distributions. The Student's t-test was used to evaluate possible associations between the SDB variable, anthropometric ones, and academic performance. The chi-squared test/χ^2 was used to compare the presence of SDB according to nutritional status. A $p < 0.05$ value was considered statistically significant.

Results

The children studied were mostly male (68.5%) with a mean age (± SD) of 9.4 years (± 2.3). The distribution by grade showed greater concentration in the second cycle (5th to 8th grade) of basic education (51.2%). Regarding academic performance, a grade point average of 6.01 ± 0.49 was observed, ranging from 4.1 to 6.8 (table 1).

Out of the anthropometric variables (table 2), we highlighted an average BMI of 21.1 ± 4.2 and based on this variable it was determined that 71.7% presented overnutrition where obesity reached 39.4%. There were no significant differences by sex both in BMI and in distribution by nutritional status.

The SDB prevalence was 32.3% and affected 22.5% of girls and 36.8% of boys, a difference that was not significant, although it marks a trend ($p = 0.152$). There was also no significant association with age, showing

Table 1. Demographic and academic characteristics

Variable		
Age (years); mean ± SD	9.4	2.3
Sex n, %		
Female	40	31.5
Male	87	68.5
Grade		
1 - 4 (first basic education level)	62	48.8
5 - 8 (second basic education level)	65	51.2
Grade point average; mean ± SD	6.01	0.49

SD: standard deviation.

Table 2. Anthropometric measurements

Anthropometric measurements	Mean	SD	Min.	Max.
Neck circumference (cm)	30.5	3.3	23.5	40
Waist circumference (cm)	69.6	11.2	46	107
Supraspinal skinfold thickness (mm)	15.3	8.0	3	42
Bicipital skinfold thickness (mm)	12.8	6.9	2	35
Tricipital skinfold thickness (mm)	17.4	6.4	5	37
Subscapular skinfold thickness (mm)	13.6	7.2	3	35
Body mass index (kg/m2)	21.1	4.2	14.1	38.4
Body fat percentage (%)	24.2	7.6	2.9	40.6
	n		%	
Nutritional Status				
Underweight	1		0.8	
Normal weight	35		27.5	
Overweight	41		32.3	
Obesity/severe obesity	50		39.4	

SD: standard deviation; Min.: minimum value; Max.: maximum value.

similar mean ages among children with and without SDB (9.2 ± 2.4 vs. 9.5 ± 2.2, respectively; p = 0.4772).

The proportion of SDB by nutritional status categories (table 3) showed no significant differences (p = 0.070). This showed that 51.2% of children with SDB were obese/severely obese while in children without SDB this proportion reached 33.7%.

In the evaluation of skinfolds according to SDB condition, a significantly higher mean was observed in schoolchildren with SDB in the bicep skinfold measurement (14.6 ± 7.3 vs. 12.0 ± 6.6; p = 0.0029) and the triceps one (19.8 ± 6.7 vs. 16.2 ± 6.0; p = 0.0497) (figure 1). The remaining skinfolds and circumference measurements showed no difference according to SDB condition.

Table 3. Distribution of SDB by Nutritional Status

Nutritional Status	SDB (-) n = 86		SDB (+) n = 41	
	n	%	n	%
Underweight	0	0	1	2.4
Normal weight	25	29.1	10	24.4
Overweight	32	37.2	9	21.9
Obesity/severe obesity	29	33.7	21	51.2
Total	86	100	41	100

SDB: sleep-disordered breathing. p = 0.070 χ^2 test.

When comparing the percentage of fat per SDB condition (Figure 2), there was a higher mean in children with the disorder (23.3 vs. 26.0; p = 0.05).

Lastly, when analyzing academic performance (overall grade point average) no significant differences were detected when comparing children with and without SDB (6.0 ± 0.45 vs. 6.0 ± 0.51; p = 0.74).

Discussion

This study has shown the high prevalence of SDB and overnutrition, presenting a high proportion of obesity among primary education students in public schools in Valdivia.

The prevalence of SDB found (32.3%) exceeds that previously reported in a Chilean study conducted in different communes of the country, which showed 17.7% in overall prevalence[17]. However, in that study, we found prevalence as high as those recorded in our work in southern communes such as Porvenir (33.3%) and Puerto Natales (36.4%). Another national study conducted in Concepción, Chile, showed a high prevalence (24.6%)[18].

There was a higher proportion of SDB in men than in women, as reported in other national[17] and international studies[5].

Among the children who presented SDB, a high percentage of them was obese (51.2%), however, considering that there was a trend, no significant association was found among these variables, unlike the study

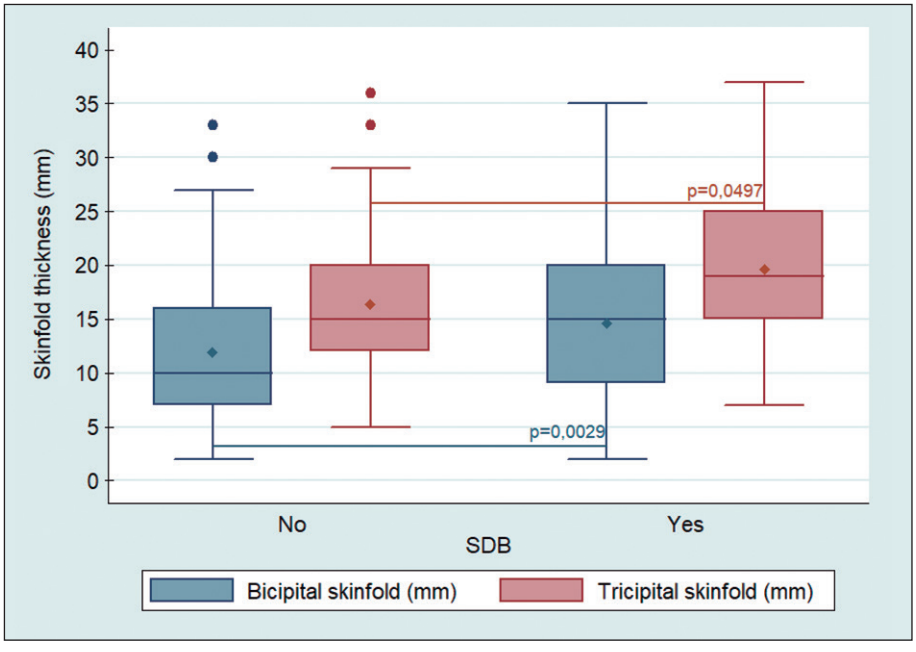

Figure 1. Bicipital and tricipital skinfold thickness by SDB condition. SDB: sleep-disordered breathing.

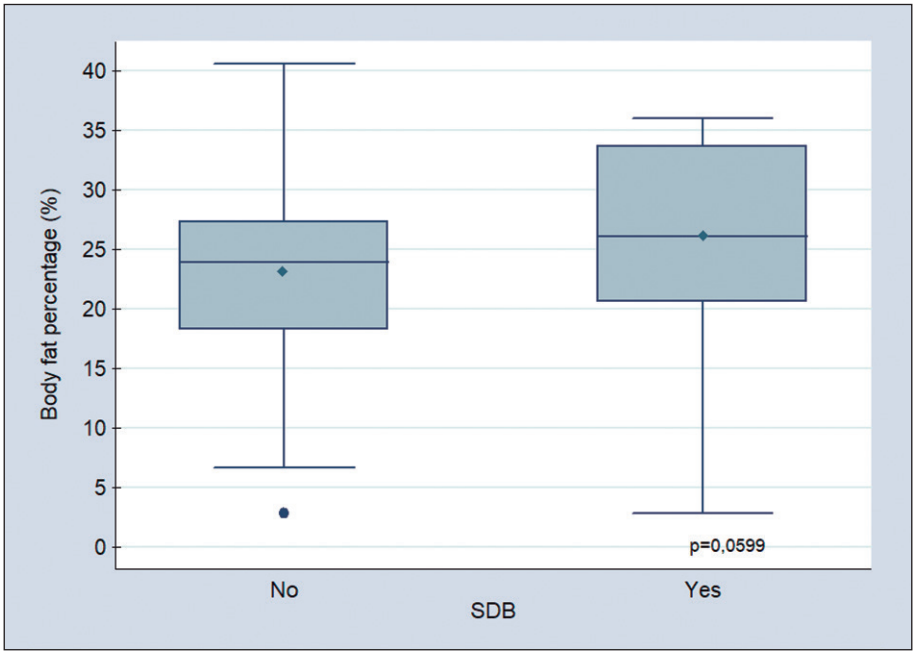

Figure 2. Body fat percentage by SDB condition. SDB: sleep-disordered breathing.

by Sanchez et al. [17] where the presence of severely obese children in the SDB group was significant.

The available evidence suggests that obesity is a risk factor for SDB in children due to physiopathological mechanisms such as airway obstruction, a tendency to collapse due to fat infiltration in the upper airway structures, and impaired ventilation, which would favor abnormalities in the ventilation response[19]. In addition, obese children with SDB are more likely to have a persistent or worsening condition over time, presenting central fat distribution and increased visceral fat in adolescence[20].

The relationship between obesity and SDB also has an impact on the quality of life in childhood, since it has shown that obese children with SDB have a worse quality of life compared with children presenting only obesity or SDB or with healthy children[21].

There was a significant relationship between the presence of SDB and anthropometric indicators such as bicep and triceps skinfolds measurement, which differs from what was found in a study conducted in Malaysia where this relationship was not verified in the bicep skinfold measurement, but there was a univariate association with neck and waist circumference[5].

Adiposity has been described as an important risk factor for the development of SDB[22,23], especially the increase in visceral fat which has increased the severity of the condition[24]. The mechanism by which adiposity predisposes to SDB is linked to alterations in the structure and function of respiratory muscles, reduced compliance of the chest wall, and deterioration of residual functional capacity[25].

Regarding academic performance, this work failed to demonstrate overall performance differences between children with and without SDB, unlike previous international and national studies that have determined a clear association between SDB and poorer school performance as represented by different measures of skills or learning domains[18,26-28]. However, as mentioned above, the performance measure was defined globally and not separated by subjects in which a specific association could be expected. Also, the execution of cognitive and academic functions was not analyzed in a focused way with specific assessment batteries.

Some limitations of this work should be commented upon to cautiously assess these results. First, the SDB detection was based on a questionnaire, which, although widely used and highly reliable, is not the gold standard for identifying SDB, as is PSG. Second, the sample size was only 60.8% of that stipulated in the study proposal, therefore, the lack of association between variables found in other research may have been due to a lack of statistical power. In the particular case of academic performance, and although it was not the focus of the study, the global measurement of this variable through the global grade point average may be masking a separate association by subjects or areas.

Finally, there were variables that we could not include in the analysis given the homogeneity of the sample since all participants attend public schools, such as the socioeconomic level, which has also been a factor related in other works to the development of SDB.

In conclusion, this study has found a high prevalence of overnutrition and SDB. Regarding the anthropometric measures, the presence of SDB was associated with increased thickness of bicep and triceps skinfolds, confirming that these are components that should be considered in the evaluation of school children.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

References

1. Brockmann PE, Bertrand P, Pardo T, et al. Prevalence of habitual snoring and associated neurocognitive consequences among Chilean school aged children. Int J Pediatr Otorhinolaryngol 2012;76:1327-31.
2. Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. Proc Am Thorac Soc 2008;5:242-52.
3. Alabi BS, Abdulkarim AA, Musa IO, et al. Prevalence of snoring and symptoms of sleep disordered breathing among primary school pupils in Ilorin, Nigeria. Int J Pediatr Otorhinolaryngol 2012;76:646-8.
4. Petry C, Pereira MU, Pitrez PM, et al. The prevalence of symptoms of sleep-disordered breathing in Brazilian schoolchildren. J Pediatr (Rio J) 2008;84:123-9.
5. Fadzil Abdullah AA, Jamalludin AR, Norrashidah AW, et al. Prevalence of sleep disordered breathing symptoms among Malay school children in a primary school in Malaysia. Med J Malaysia 2012;67:181-5.
6. Urschitz MS, Guenther A, Eitner S, et al. Risk factors and natural history of habitual snoring. Chest 2004;126: 790-800.
7. Pardo T, Holmgren NL, Cerda J, et al. Prevalencia disímil de trastornos respiratorios del sueño en escolares. Rev Chil Pediatr 2013;84:145-51.
8. Stehling F, Keull J, Olivier M, et al. Validation of the screening tool ApneaLink(R) in comparison to polysomnography for the diagnosis of sleep-disordered breathing in children and adolescents. Sleep Med 2017;37:13-8.
9. Vila MT, Miralles Torres A, Beseler Soto B. Versión española del Pediatric Sleep Questionnaire. Un instrumento útil en la investigación de los trastornos del sueño en la infancia. Análisis de su fiabilidad. An Pediatr (Barc) 2007;66:121-8.
10. Koren D, Gozal D, Philby MF, et al. Impact of obstructive sleep apnoea on insulin resistance in nonobese and obese children. Eur Respir J 2016;47:1152-61.
11. Agencia de Calidad de la Educación. Estudio Nacional de Educación Física 2015. [Internet]. 2016. Disponible en http://www.revistadeeducacion.cl/wp-content/uploads/2016/10/PRESENTACION-ED-FISICA.pdf.
12. Brockmann PE, Urschitz MS, Schlaud M, et al. Primary snoring in school children: prevalence and neurocognitive impairments. Sleep Breath 2012;16:23-9.
13. Ministerio de Salud. Subsecretaría de Salud Pública. Norma para la evaluación nutricional de niños, niñas y adolescentes de 5 a 19 años de edad. Santiago: Ministerio de Salud. 2016.
14. Lohman TG. Applicability of body composition techniques and constants for children and youths. Exerc Sport Sci Rev 1986;14:325-57.
15. Martínez Sopena MJ, Redondo Del Río MP, Alonso Franch M. Valoración estado nutricional del obeso: estimación de la masa grasa. Bol Pediatr 2006;46:275-91.
16. Bertran K, Mesa T, Rosso K, et al. Diagnostic accuracy of the Spanish version of the Pediatric Sleep Questionnaire for screening of obstructive sleep apnea in habitually snoring children. Sleep Med 2015;16:631-6.
17. Sánchez T, Rojas C, Casals M, et al. Trastornos respiratorios del sueño en niños escolares chilenos: prevalencia y factores de riesgo. Rev Chil Pediatr 2018;89:718-25.
18. Gatica D, Rodriguez-Nunez I, Zenteno D, et al. Association between sleep-related breathing disorders and academic performance among children from Concepcion, Chile. Arch Argent Pediatr 2017;115:497-500.
19. Esteller-Moréa E, Castells-Vilella L, Segarra-Isernc F, et al. Obesidad infantil y trastornos respiratorios del sueño. Acta Otorrinolaringol Esp 2012;63:180-6.
20. Frye SS, Fernández-Mendoza J, Calhoun SL, et al. Childhood obesity, weight loss and developmental trajectories predict the persistence and remission of childhood sleep-disordered breathing. Pediatr Obes 2019;14.
21. Katz SL, MacLean JE, Barrowman N, et al. Long-Term Impact of Sleep-Disordered Breathing on Quality of Life in Children With Obesity. J Clin Sleep Med 2018;14:451-8.
22. Verhulst SL, Schrauwen N, Haentjens D, et al. Sleep-disordered breathing in overweight and obese children and adolescents: prevalence, characteristics and the role of fat distribution. Arch Dis Child 2007;92:205-8.
23. Verhulst SL, Van Gaal L, De Backer W, et al. The prevalence, anatomical correlates and treatment of sleep-disordered breathing in obese children and adolescents. Sleep Med Rev 2008;12:339-46.
24. Bixler EO, Fernandez-Mendoza J, Liao D, Calhoun S, Rodriguez-Colon SM, Gaines J, et al. Natural history of sleep disordered breathing in prepubertal children transitioning to adolescence. Eur Respir J 2016;47:1402-9.
25. Kohler MJ, van den Heuvel CJ. Is there a clear link between overweight/obesity and sleep disordered breathing in children? Sleep Med Rev 2008;12:347-61.
26. Gottlieb DJ, Chase C, Vezina RM, et al. Sleep-disordered breathing symptoms are associated with poorer cognitive function in 5-year-old children. J Pediatr 2004;145:458-64.
27. Bourke R, Anderson V, Yang JS, et al. Cognitive and academic functions are impaired in children with all severities of sleep-disordered breathing. Sleep Med 2011;12:489-96.
28. Galland B, Spruyt K, Dawes P, et al. Sleep disordered breathing and academic performance: a meta-analysis. Pediatrics 2015;136(4):e934-46.