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ORIGINAL ARTICLE

Prevalence and risk factors for sleep-disordered breathing in chilean schoolchildren

Trastornos respiratorios del sueño en niños escolares chilenos: prevalencia y factores de riesgo

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Abstract

Objectives: To describe the prevalence of sleep-disordered breathing (SDB) in Chilean schoolchildren and study associated risk factors. **Patients and Method:** We carried out a transversal and descriptive study. Questionnaires were sent to the parents of children attending first year of elementary school in the Metropolitan Region (Santiago), the Biobío Region (Concepción, Chillán, Yumbel) and the Magallanes Region (Porvenir and Puerto Natales). Anthropometric data, school performance, household characteristics, indoor pollutants, medical history, and current symptoms of asthma, allergic rhinitis, and atopic dermatitis were recorded. The nutritional status was determined according to z-BMI. A pediatric sleep questionnaire validated in Spanish (PSQ) was applied. **Results:** 564 questionnaires were analyzed, the median age was six years (range 5 to 9), 44.9% male. The SDB prevalence was 17.7% (n = 100): 6% in Vitacura (Metropolitan Region), 28.7% in Chillán (Biobío Region), and 36.4% in Puerto Natales (Magallanes Region) (p = 0.001). The group with SDB had a higher proportion of men (54.5 vs 42.8%, p = 0.033), lower academic performance (overall grade point average 6.36 ± 0.48 vs 6.56 ± 0.34, p = 0.001), lower maternal higher education (44.4% vs 69.9%, p = 0.001), and higher exposure to indoor pollutants than those without SDB. After the multivariate analysis, symptoms of rhinitis in the last 12 months (OR 4.79, 95% CI 2.20-10.43) and lower maternal educational level (OR 3.51; 95% CI 1.53-8.02) remained as predictors of SDB. **Conclusions:** Chilean schoolchildren have a high prevalence of SDB with demographic differences. It was associated with social risk factors, more specific factors of lung damage, and worse sleep quality and quantity.

Keywords:
Sleep; sleep-disordered breathing;
asthma;
allergic rhinitis

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Introduction

Sleep-disordered breathing (SDB) in children is an inflammatory disease characterized by variable upper airway obstruction and different degrees of disturbance in gas exchange during the night. Its presentation spectrum varies from habitual snoring to complete obstruction of the airway, so called obstructive sleep apnea (OSA)[1,2].

Different tools have been developed for the diagnosis of SDB. First, history and physical examination, although they guide to these pathologies, have shown to have low sensitivity and specificity[3]. Polysomnography (PSG) measures various neurophysiological and cardiorespiratory parameters, and is considered the gold standard for OSA. Its disadvantages are the limited availability of health centers that perform it and its high cost. Given this, several diagnostic alternatives have been developed, such as respiratory polygraphy, urinary biomarkers, anterior rhinomanometry, and questionnaires of nocturnal respiratory symptoms and diurnal symptoms associated with SDB, among others. These were compared to the gold standard in a systematic review[4] showing an adequate diagnostic accuracy. Within the sleep questionnaires, the pediatric sleep questionnaire (PSQ) was developed by Chervin et al[5] and demonstrated excellent sensitivity and specificity (71% and 51% respectively) to identify children with OSAS when applied in a group of frequent snorers and compared to a control group. Its main advantage is the simplicity of use, its low cost and a precise cutoff (score > 0.33) that can be used for screening OSA. This cutoff demonstrated predicting OSAS in PSG with an OR of 2.8 (95% CI 1.68 - 4.68)[6].

There is wide evidence that SDB constitutes an important cause of metabolic[7], cardiovascular[8,9] and neurocognitive[10,11] morbidity in the pediatric population[12]. Their early detection and management are fundamental since they can result in relief of symptoms, improve quality of life, prevent sequelae, educate parents, and decrease the use of health resources[1]. The reported prevalence of this disorder in the literature is quite variable, ranging from less than 3%[13] to approximately 35%[14] in the pediatric population. A study of our group already demonstrated that in Santiago there was a dissimilar prevalence of snoring children in two communes, being 18.2% in Puente Alto and 0.7% in Providencia[15]. Another study carried out in Concepción found a SDB prevalence based on the PSQ of 24.6% in 256 children between six and 14 years of age, higher than previously reported[16]. However, studies regarding the prevalence and risk factors associated with SDB in Chilean schoolchildren are scarce. In addition, it is not known whether its prevalence varies in different regions of the country.

The objective of this study is to describe the SDB prevalence in Chilean schoolchildren living in three different regions of Chile, analyzing several associated risk factors: anthropometric characteristics, ethnicity, academic performance and comorbidity (obesity, asthma, allergic rhinitis, and atopic dermatitis).

Patients and Method

Study design and participants

A descriptive, cross-sectional study was conducted in Chile between May 2015 and July 2016. Different schools were randomly recruited from different communes of different socioeconomic levels in the Metropolitan, Biobío, and Magallanes Regions. The schools in which the principals agreed to participate were incorporated to the study. A convenience sampling was carried out.

N=1,092 questionnaires were distributed to parents of children in their first year of primary school, with a 53.8% return rate. It was necessary to exclude 22 subjects who did not have signed informed consent and two who sent the consent but did not complete the questionnaire. **Figure 1** shows the selection flow of study subjects.

Sociodemographic data such as age, gender, weight in kilos (kg), height in centimeters (cms), and grades from several subjects (language, physical education, mathematics, natural sciences, and overall grade point average)were collected. School grades range from 2.0 to 7.0. In addition, the questionnaire included household data such as housing type (house or apartment), number of stories, household size in square meters (m^2), number of rooms, number of inhabitants (children and adults), indigenous origin, educational level of parents, and monthly family income. The monthly family income was converted to US dollars (USD). Finally, we asked about indoor pollutants such as pets, indoor/outdoor smoking, and heating type used in winter.

We calculated the body mass index (BMI = weight [kg]/height [m^2]) and z-BMI with AnthroPlus®[18], determining nutritional status as follows: malnutrition ≤ -2 SD, malnutrition risk -1 to -1.9 SD, eutrophy 0.9 to -0.9 SD, overweight 1 to 1.9 SD, obesity 2 to 2.9 SD, and severe obesity ≥ 3 SD.

Approval was obtained from the Ethics Committee of the Pontifical Catholic University of Chile (#project 14-541). Informed consent was requested along with the questionnaires, and parents kept a copy and the researchers' contact details.

Respiratory symptoms and sleep

Parents reported on the child's and family history of asthma, allergic rhinitis and OSAS. For sleep-related

respiratory symptoms, the parents answered the PSQ[5], which is validated in Spanish[19]. This questionnaire was applied in Chile compared to gold standard (PSG) with a 0.714 sensitivity, 0.521 specificity, a 0.521 positive predictive value and a 0.714 negative predictive value for the 0.33 cut-off point[20]. It has 22 questions regarding various symptoms including characteristics of snoring (duration, intensity, and frequency), episodes of apnea, mouth breathing, presence of enuresis, diurnal hypersomnolence, headache, overweight, hyperactivity symptoms, impulsivity, and inattention. The 0.33 cut-off point was used in our study to identify children at high risk of having a sleep-disordered breathing[5].

For current respiratory symptoms, the International Study of Asthma and Allergies (ISAAC)[21] questions for asthma, allergic rhinitis, and atopic dermatitis were applied.

Statistical analysis

For descriptive statistics, we used median, minimum, and maximum for continuous; and number and percentage for categorical variables, in case of non-normal distribution. Non-parametric Mann-Whitney and Kruskal-Wallis tests were applied for quantitative variables. Spearman correlation was used to compare numerical variables. A $p < 0.05$ value was considered statistically significant.

In order to analyze the association between different factors and SDB, a multivariable analysis was carried out using binary logistic regression, expressing the results as odds ratio (OR) with a 95% confidence interval. The model was adjusted for following sociodemographic variables: age, gender, mother's level of education, pet ownership, and smoke exposure at home. All analyses were performed using the SPSS Statistics software version 24 for MAC.

Results

A total of n=564 surveys were analyzed. Overall SDB prevalence was 17.7% (n=100), with differences between communes and regions; 6% in Vitacura (Metropolitan Region), 28.7% in Chillán (Biobío Region), and 36.4% in Puerto Natales (Magallanes Region) ($p = 0.001$). Figure 2 shows the SDB prevalence in different communes.

Table 1 summarizes the main characteristics of the subjects included in the study, with and without SDB defined by PSQ score. The group with SDB had significantly more males than the group without SDB; 54.5% vs 42.8% respectively ($p = 0.033$). The group with SDB tended to have a higher z-BMI than the group without SDB; 0.82 (± 1.8) vs 0.63 (± 1.6), but this difference was not significant ($p = 0.276$). The presence of severely obese children in the SDB group was significant; 12.2% vs. 4.3% in those without SDB ($p = 0.038$). In terms of academic performance, children with SDB performed worse in all subjects assessed (language, mathematics, science, and physical education) and on their overall GPA. The SDB group had a 6.36 overall GPA (± 0.48) vs. 6.56 (± 0.34) in the non-SDB group, with $p = 0.001$.

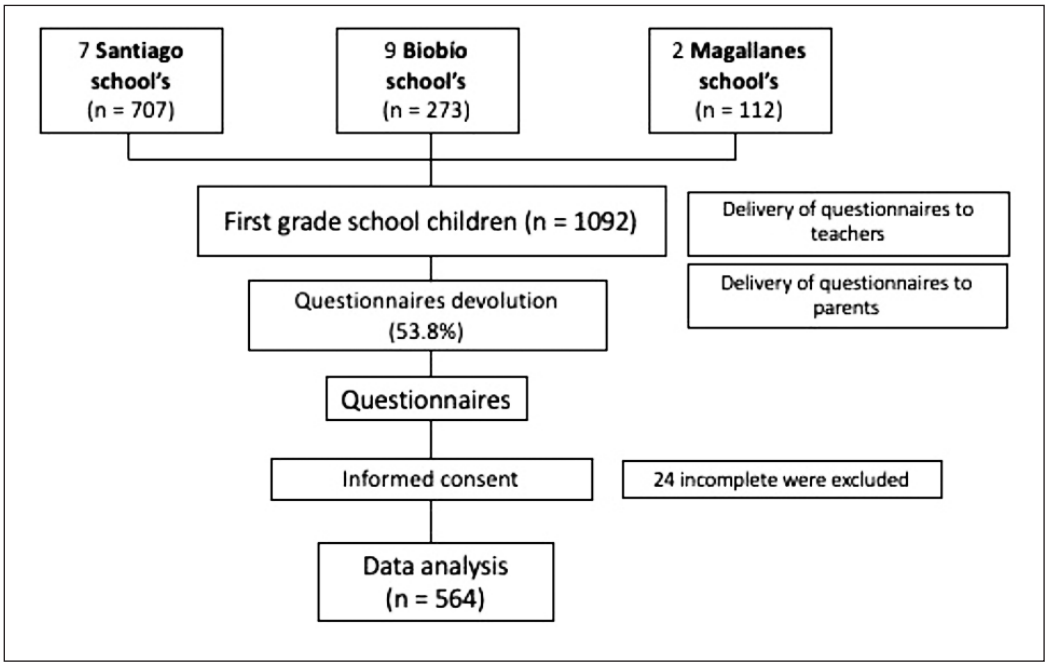

Figure 1. Study design.

The educational level of the parents showed an inverse association with SDB, a higher educational level of the parents was associated with a lower SDB prevalence. Mothers of children without SDB had 69.9% of technical or higher studies compared to 44.4% of mothers of children with SDB ($p < 0.001$). Family income was also associated with SDB.Families of children with SDB tend to have lower monthly income in USD, a significant difference ($p < 0.001$): 68% with income less than or equal to 1,300 USD vs 37.8% in children without SDB. In addition, we found a significant association of SDB with indigenous parental origin, mainly mapuche; 14.6% vs. 6.6% ($p = 0.011$).

Families of children with SDB had smaller houses compared to those without SDB (87 m^2 vs 140 m^2, $p = 0.003$). No significant differences were found in the number of stories in the house, rooms, total inhabitants or the number of adults. Regarding indoor pollutants, children with SDB were more likely to be exposed to passive smoke (inside and outside the home), 53% vs 37.1% ($p = 0.003$), and to have pets inside the home, 43.4% vs 31.4% ($p = 0.021$). No differences were found between heating type used during winter in both groups (kerosene, wood, gas, electric, or other).

Regarding previous diagnosis of asthma and allergic rhinitis, there were no significant differences between the groups with and without SDB. There was also no significant difference in family history of asthma, allergic rhinitis nor OSAS for children with or without SDB. However, when analyzing ISAAC questions for asthma, allergic rhinitis, and atopic dermatitis, all presented statistically significant differences, being most frequently positive in the SDB group. Table 2 summarizes these results. For the entire cohort, we found a prevalence of wheezing that interrupted sleep at least once a week of 47.2% and nocturnal dry cough in the last 12 months of 28.6%. Children with SDB had significantly more wheezing in the past 12 months (25.3% vs 11.1%, $p < 0.001$), and more rhinitis symptoms such as frequent sneezing, runny nose, or nasal congestion without infectious intercurrence in the last 12 months (68.5% vs 34.8%, $p < 0.001$) compared to those without SDB.

Regarding nocturnal respiratory symptoms, 20.2% of the total sample reported to snore more than half the time, 19% snored always, and 20.4% snored loudly. 5.4% of the parents acknowledged that their child had episodes when he or she stopped breathing at night. In terms of sleep duration, the total group of children slept a median of 10 hours during the week (7-12.5 hrs) and 11 hrs during the weekend (7.5-14.5 hrs). When analyzing groups with and without SDB, children with SDB slept an average of 14.4 minutes less on weekdays ($p = 0.002$), without significant differences in the number of hours that both groups slept on the weekend.

A multivariate analysis was performed for factors associated with the presence of SDB in schoolchildren. Variables that presented a significant association in the univariate analysis (sex, general grade point average, father and/or mother belonging to indigenous people, educational level of the mother, wheezing in the last 12 months, rhinitis symptoms in the last 12 months, and eczema in the last 12 months) were included. Low educational level of the mother (OR 3.51 (95% CI 1.53-8.02, $p = 0.003$)), and child's rhinitic symptoms in the last 12 months (OR 4.79 (95% CI 2.20-10.43, $p < 0.001$)) were significant predictors of SDB.

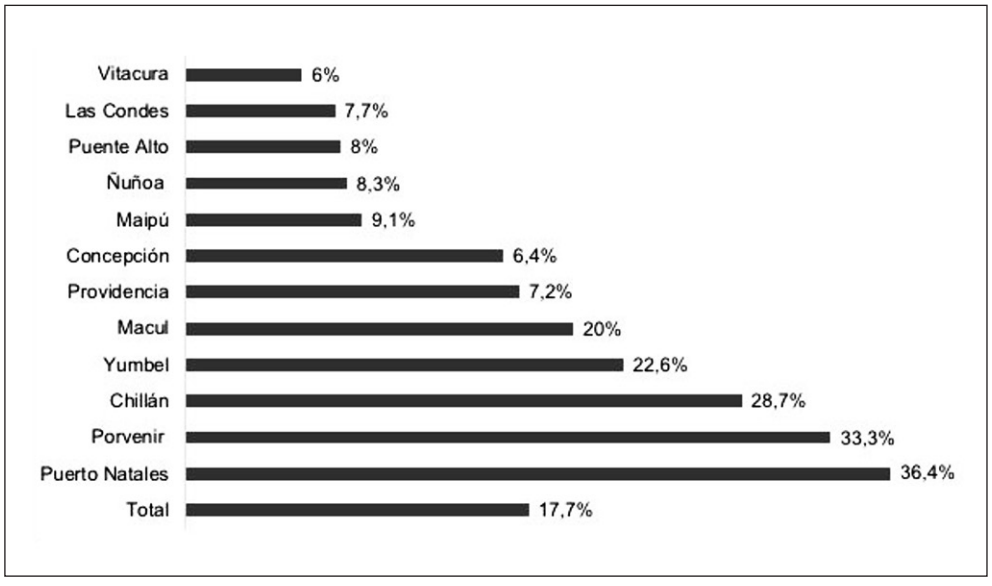

Figure 2. Sleep disordered breathing (SDB) prevalence (%) in Chilean schoolchildren, differences for communes (Metropolitan, Biobío and Magallanes regions).

Table 1. Participant's characteristics with or without SDB defined by PSQ

	Total sample (n = 564)	SDB (+) (n = 100)	SDB (-) (n = 464)	p
Age in years	6 (5 - 9)	6 (5 - 7)	6 (5 - 9)	0.434
Male sex	44.9 (250)	54.5 (54)	42.8 (196)	0.033*
zBMI, mean (SD)	0.66 (± 1.64)	0.82 (± 1.8)	0.63 (± 1.6)	0.276
Severe obesity (zBMI) (≥ 3 SD)	5.6 (17)	12.2 (6)	4.3 (11)	0.038*
Mother's higher education	65.4 (362)	44.4 (44)	69.9 (318)	0.000*
Father's higher education	64.5 (343)	46.8 (44)	68.2 (299)	0.001*
Socioeconomic income, tertiles				0.000*
High (> 3.000 USD)	45 (245)	23.7 (23)	49.7 (222)	
Middle (1.300 - 3.000 USD)	11.8 (64)	8.2 (8)	12.5 (56)	
Low (< 1.300 USD)	45 (245)	68 (66)	37.8 (169)	
Indigenous population	7.9 (42)	14.6 (13)	6.6 (29)	0.011*
Pets indoors	33.5 (188)	43.4 (43)	31.4 (145)	0.021*
Secondhand smoking	40 (225)	53 (53)	37.1 (172)	0.003*
Asthma (previous diagnosis)	10.2 (57)	15.2 (15)	9.1 (42)	0.071
Allergic rhinitis (previous diagnosis)	21.8 (121)	25.5 (25)	21.1 (96)	0.333
Sleep hours weekday	10 (7 - 12.5)	9.8 (7 - 11.3)	10 (7.8 - 12.5)	0.002*
Sleep hours weekend	11 (7.5 - 14.5)	11 (8 - 13.5)	11 (7.5 - 14.5)	0.579

Data are presented as median (range) or % (n), unless otherwise stated. *p < 0.05 was considered statistically significant. Definition of abbreviations: SDB = sleep disordered breathing; PSQ = pediatric sleep questionnaire, zBMI = Z score body mass index, SD = standard deviation.

Table 2. ISAAC questions for asma, allergic rhinitis and atopic dermatitis in participant's with or without SDB defined by PSQ

	SDB (+) (n = 100)	SDB (-) (n = 464)	p
Asthma			
Wheezing ever	65.2 (60)	38.2 (170)	< 0.001*
Wheezing last 12 months	25.3 (23)	11.1 (50)	< 0.001*
Sleep disturbed due to wheezing	8.3 (8)	0.4 (2)	< 0.001*
Allergic rhinitis			
Rhinitis symptoms ever	77.7 (73)	41.8 (187)	< 0.001*
Rhinitis symptoms last 12 months	68.5 (63)	34.8 (157)	< 0.001*
Conjunctivitis symptoms	47.1 (40)	16.7 (75)	< 0.001*
Atopic dermatitis			
Eczema ever	25.8 (24)	11.2 (51)	< 0.001*
Eczema last 12 months	22.3 (21)	10.6 (48)	0.002*
Eczema typical places	16.9 (15)	8.6 (39)	0.017*

Data are presented as % (n). *p < 0.05 was considered statistically significant. Definition of abbreviations: SDB = sleep disordered breathing; PSQ = pediatric sleep questionnaire, ISAAC= International Study of Asthma and Allergies.

Discussion

This study found a high SDB prevalence in Chilean schoolchildren (17.7%), similar to that reported in international studies[13,14]. There were also differences in sociodemographic level, housing, ethnic/family and prevalence of chronic respiratory pathologies related with the prevalence of SDB.

The higher SDB prevalence in boys than in girls found in our study has been previously described. In children and adolescents, there are sociocultural, hormonal, metabolic, and anatomical factors that may explain this trend[22]. Several studies have shown that obesity is an independent risk factor for SDB in the pediatric population[23-25]. Multiple physiopathologic mechanisms are described to link both diseases; such as narrowing of the upper airway by local fat infiltration and a greater work of breathing by increased body fat[26]. Although no significant differences were seen in the nutritional status of patients with and without SDB in our study, the SDB group tends to have more severe obesity.

There is consistent evidence concerning an association between SDB and neurocognitive consequences in school-age population[26-28]. In previous studies in Chile, children with SDB showed significantly lower performance in language and physical education[26] subjects and in mathematics and science[16]. Similarly, the differences in school performance found in our study could show a deterioration in the daytime cognitive functioning of schoolchildren. It is important to note that formal neurocognitive evaluations may be required to better characterize possible consequences in children with SDB.

The association between OSAS and race/ethnicity has also been described; there has been a significant association between African American children and the presence of SDB[27.29]. Our study found a significant association between SDB and parents of indigenous origin, mainly mapuches. We believe that there are anatomical maxillofacial relationships characteristic of these indigenous people that may predispose to snoring or apneas in sleep.

Schoolchildren without SDB were also found to have larger houses than the SDB group, findings that are consistent with what was published in previous studies[23]. Since the perception of snoring depends on the presence of a family member near the child during the night, having a smaller home may lead to more accurate reporting of snoring[24]. On the other hand, having smaller homes may be associated with more crowded conditions, indoor pollutants, and poor ventilation, with a predisposition to having SDB. In our study, the higher SDB prevalence in southern cities could be explained by higher levels of indoor pollutants such as wood heating.

As in international literature, an inverse relationship was found between family income level and SDB[25], which could be partly explained by overcrowding[23], but also by multiple other factors. For example, the possibility of the family to provide a physical environment that facilitates fall asleep and maintains the sleep[30], lower opportunities of access to health with a delay of the diagnosis and treatment of patients and lower level of education of both parents. The educational level of the mother remained as a predictor of SDB after multivariate analysis, which in other studies has been considered a poverty marker. Higher levels of poverty lead to poorer environmental conditions for children that can lead to the development of SDB and other chronic diseases, especially respiratory diseases.

Passive smoking is a known risk factor for SDB in children, which is reinforced by our study. Since snoring affects on the diameter of the pharynx, smoke exposure can cause, in other alterations, edema and inflammation of the mucosa, resulting in a decrease in the diameter of the pharynx and increased snoring and apneas during sleep[23.24]. Passive smoke exposure in children has been shown to predispose to recurrent respiratory infections, alter the quality and quantity of sleep in children and decrease neurological development in infants[31,32].

The association between allergic rhinitis, asthma and SDB has been widely studied[33,34], with atopy being one of the highest risk factors for SDB[34]. Being both (SDB and asthma) inflammatory diseases of the airway, the presence of one can cause or exacerbate the other, and there may be a bidirectional relationship. Thus, treatment of asthma may improve nocturnal symptoms in children with SDB and treatment of asthmatic children with SDB (e.g. adenotonsillectomy) may improve asthma exacerbations[35,36]. This is what sustains the theory of the "single airway", a continuous of respiratory pathologies[37]. Although our study showed no association between prior diagnosis of allergic rhinitis, asthma, and SDB; when asked about symptoms of these pathologies, all were significantly more frequent in the SDB group. A sub-diagnosis of asthma and allergic rhinitis is striking, with a challenge to optimize the treatment of frequent chronic respiratory pathologies in children, improving nocturnal respiratory symptoms and avoiding the consequences already described of SDB. There are also studies that correlate SDB and atopic dermatitis, where patients with OSAS were at greater risk of developing atopic dermatitis[38]. Our study emphasizes the importance of investigating atopy and managing it early to improve the quality of life and sleep of children.

There are limitations in our study; sampling was for convenience and may not be representative. We did not use formal sleep study due to the high costs involved, however, we applied a validated questionnaire in our language and which has been previously applied in our population with good correlation. On the other hand, the questionnaires were applied by different surveyors in each city so that the differences reported in these could be partly explained by a possible bias of the surveyor.

Notwithstanding that, we rescue several strengths of this study such as the number of children surveyed, from different cities in Chile and which could be described in terms of several sociodemographic characteristics, respiratory symptoms of sleep and atopy (asthma, allergic rhinitis, and atopic dermatitis).

Conclusions

According to their parents, Chilean first-grade schoolchildren have a high SDB prevalence, among to the highest rates worldwide. Differences in SDB prevalence were found between the included cities and communes. SDB in Chilean schoolchildren was associated with social risk factors, lung diseases, and worse quantity and quality of sleep. It would be interesting to be able to carry out future studies to evaluate physiopathological mechanisms and statistical causality of the factors associated with SDB, in order to be able to intervene them in a more appropriate way.

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.

Financial Disclosure

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

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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References

1. Marcus CL, Brooks LJ, Draper KA, et al. Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome. Pediatrics. 2012;130:576-84.
2. Katz ES, D'Ambrosio CM. Pathophysiology of Pediatric Obstructive Sleep Apnea. Proc Am Thorac Soc. 2008; 5: 253-62.
3. Certal V, Catumbela E, Winck JC, Azevedo I, Teixeira-Pinto A, Costa-Pereira A. Clinical assessment of pediatric obstructive sleep apnea: A systematic review and meta-analysis. Laryngoscope. 2012;122:2105-14.
4. Brockmann PE, Schaefer C, Poets A, Poets CF, Urschitz MS. Diagnosis of obstructive sleep apnea in children: A systematic review. Sleep Med Rev 2013;17:331-40.
5. Chervin RD, Hedger K, Dillon JE, Pituch KJ. Pediatric sleep questionnaire (PSQ): validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. Sleep Med 2000;1:21-32.
6. Chervin RD, Weatherly RA, Garetz SL, et al. Pediatric Sleep Questionnaire. Arch Otolaryngol Neck Surg. 2007;133:216.
7. Gozal D, Sans Capdevila O, Kheirandish-Gozal L. Metabolic alterations and systemic inflammation in obstructive sleep apnea among nonobese and obese prepubertal children. Am J Respir Crit Care Med. 2008;177:1142-9.
8. Gozal D, Kheirandish-Gozal L. Cardiovascular Morbidity in Obstructive Sleep Apnea. Am J Respir Crit Care Med. 2008;177:369-75.
9. Kheirandish-Gozal L, Bhattacharjee R, Gozal D. Autonomic alterations and endothelial dysfunction in pediatric obstructive sleep apnea. Sleep Med. 2010;11:714-20.
10. Beebe DW. Neurobehavioral morbidity associated with disordered breathing during sleep in children: A comprehensive review. Sleep. 2006;29:1115-34.
11. Owens JA. Neurocognitive and behavioral impact of sleep disordered breathing in children. Pediatr Pulmonol. 2009;44:414-22.
12. Elso TMJ, Brockmann VP, Zenteno AD. Consecuencias del síndrome de apnea obstructiva del sueño. Rev Chil Pediatría. 2013;84:128-37.
13. Spruyt K, O'Brien LM, Macmillan Coxon AP, Cluydts R, Verleye G, Ferri R. Multidimensional scaling of pediatric sleep breathing problems and bio-behavioral correlates. Sleep Med. 2006;7:269-80.
14. Castronovo V, Zucconi M, Nosetti L, et al. Prevalence of habitual snoring and sleep-disordered breathing in preschool-aged children in an Italian community. J Pediatr 2003;142:377-82.
15. Pardo TT, Holmgren PNL, Cerda LJ, Brockmann VPE. Prevalencia disímil de trastornos respiratorios del sueño en escolares. Rev Chil Pediatría 2013;84:145-51.
16. Gatica D, Zenteno D, Elso J, Montesinos JJ, Manterola C. Asociación entre trastornos respiratorios del sueño y rendimiento académico en niños de Concepción, Chile. Arch Argent Pediatr. 2017;115:497-501.
17. WHO. WHO Growth reference data for 5-19 yearshttp://www.who.int/growthref/en/ (2007, accessed 22 June 2017).
18. WHO. WHO AnthroPlus softwarehttp://www.who.int/growthref/tools/en/ (2009, accessed 22 June 2017).
19. Tomás Vila M, 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 Pediatría 2007;66:121-8.
20. Bertran K, Mesa T, Rosso K, Krakowiak MJ, Pincheira E, Brockmann PE. 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.
21. Asher MI, Keil U, Anderson HR, et al. International study of asthma and allergies in childhood (ISAAC): Rationale and methods. Eur Respir J 1995;8:483-91.
22. Brockmann PE, Koren D, Kheirandish-Gozal L, Gozal D. Gender dimorphism in pediatric OSA: Is it for real? Respir Physiol Neurobiol 2017;245:83-8.
23. Urschitz MS, Guenther A, Eitner S, et al. Risk Factors and Natural History of Habitual Snoring. Chest. 2004;126:790-800.
24. Corbo GM, Forastiere F, Agabiti N, et al. Snoring in 9- to 15-Year-Old Children: Risk Factors and Clinical Relevance. Pediatrics 2001;108:1149-56.
25. Li S, Jin X, Yan C, Wu S, Jiang F, Shen X. Habitual snoring in school-aged children: environmental and biological predictors. Respir Res. 2010;11:144.
26. Brockmann PE, Bertrand P, Pardo T, Cerda J, Reyes B, Holmgren NL. Prevalence of habitual snoring and associated neurocognitive consequences among Chilean school aged children. Int J Pediatr Otorhinolaryngol. 2012;76:1327-31.
27. Galland B, Spruyt K, Dawes P, McDowall PS, Elder D, Schaughency E. Sleep Disordered Breathing and Academic Performance: A Meta-analysis. Pediatrics 2015;136: e934-46.
28. Brockmann PE, Urschitz MS, Schlaud M, Poets CF. Primary snoring in school children: Prevalence and neurocognitive

impairments. Sleep Breath. 2012;16:23-9.
29. Boss EF, Smith DF, Ishman SL. Racial/ethnic and socioeconomic disparities in the diagnosis and treatment of sleep-disordered breathing in children. Int J Pediatr Otorhinolaryngol. 2011;75:299-307.
30. El-Sheikh M, Bagley EJ, Keiley M, Elmore-Staton L, Chen E, Buckhalt JA. Economic adversity and children's sleep problems: Multiple indicators and moderation of effects. Heal Psychol. 2013; 32:849-59.
31. Montgomery-Downs HE. Snore-Associated Sleep Fragmentation in Infancy: Mental Development Effects and Contribution of Secondhand Cigarette Smoke Exposure. Pediatrics 2006; 117:e496-e502.
32. Jara SM, Benke JR, Lin SY, Ishman SL. The association between secondhand smoke and sleep-disordered breathing in children: A systematic review. Laryngoscope. 2015;125:241-7.
33. Brockmann PE, Bertrand P, Castro-Rodriguez JA. Influence of asthma on sleep disordered breathing in children: A systematic review. Sleep Med Rev. 2014;18:393-7.
34. Chng SY, Goh DYT, Wang XS, Tan TN, Ong NBH. Snoring and atopic disease: A strong association. Pediatr Pulmonol 2004;38:210-6.
35. Sánchez T, Castro-Rodríguez JA, Brockmann PE. Sleep-disordered breathing in children with asthma: a systematic review on the impact of treatment. J Asthma Allergy 2016;9:83.
36. Min YZ, Subbarao P, Narang I. The Bidirectional Relationship Between Asthma and Obstructive Sleep Apnea: Which Came First? J Pediatr 2016;176:10-6.
37. Gozal D. Pediatric OSA: A case for 'united we stand' in the way of a breath. Pediatr Pulmonol 2010;45:1151-2.
38. Tien K-J, Chou C-W, Lee S-Y, et al. Obstructive Sleep Apnea and the Risk of Atopic Dermatitis: A Population-Based Case Control Study. PLoS One 2014;9:e89656.