Prevalence of sleep-disordered breathing among adolescents and its association with the presence of obesity and hypertension

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Funding:
This study was developed thanks to the funding provided by the Ministry of Social Welfare of the Province of La Pampa and Universidad Nacional de La Pampa.

Conflict of interest:
None.

Received: 10-23-2020
Accepted: 2-8-2021

ABSTRACT

Introduction: The increased prevalence of sleep-disordered breathing (SDB) and its association with obesity and hypertension (HTN) have not been thoroughly explored in adolescents. The objective of this study was to investigate the prevalence of SDB and snoring in this population and analyze its association with obesity and HTN.

Population and methods: This was a descriptive, cross-sectional study in a sample of adolescents. Weight, height, waist and neck circumference, and blood pressure were measured, and the Pediatric Sleep Questionnaire (PSQ) was administered.

Results: A total of 826 adolescents participated, 58 (7 %) had SDB (males: 5.8 %; females: 8 %), and 80 (9.7 %) were considered snorers (males: 10.4 %; females: 9.1 %). Overweight and obesity were detected in 216 (26.2 %) and 149 (18 %) participants, respectively. A higher proportion of subjects with obesity had SDB compared to those who were not obese (12.8 % versus 5.8 %; $p = 0.004$). The same association was observed with snoring (18.2 % versus 7.8 %; $p < 0.001$). Also, 24.6 % slept less than 8 hours a day and 12.6 % had values compatible with HTN, with a significant association with obesity and sleep hours.

Conclusion: A high prevalence of SDB and snoring was observed in adolescents, together with an association with obesity and HTN, which highlights the relevance of addressing this problem in an early manner in order to prevent complications.

Key words: *sleep disorders; snoring; obesity; hypertension; adolescents.*

http://dx.doi.org/10.5546/aap.2021.eng.245

To cite: Fraire JA, Deltetto NM, Catalani F, Beneitez A, et al. Prevalence of sleep-disordered breathing among adolescents and its association with the presence of obesity and hypertension. *Arch Argent Pediatr* 2021;119(4):245-250.

INTRODUCTION

The term sleep-disordered breathing (SDB) describes a syndrome characterized by variable upper airway obstruction. It encompasses several clinical conditions, from primary snoring to obstructive sleep apnea syndrome (OSAS). It has been estimated that between 1 % and 4 % of the general pediatric population and between 4 % and 11 % of adolescents have SDB.[1,2]

Although it has been considered that SDB in children results from anatomical abnormalities in the upper airways, obesity has been recognized as an important risk factor for the development of this disorder.[3]

Obesity has become a worldwide health problem due to its increased prevalence. Moreover, childhood obesity is an ongoing problem because more than 50 % of children with obesity will be obese adults.[4]

Adolescents with obesity and SDB may show alterations in blood pressure (BP) control and a higher probability of dyslipidemia and insulin resistance, which may be totally or partially reversed with an adequate management.[3]

The objective of this study was to investigate the prevalence of SDB and snoring in adolescents and analyze its association with obesity and hypertension (HTN).

POPULATION AND METHODS

This was an epidemiological, descriptive, and cross-sectional study. Between August and October 2018, as part of an initiative agreed upon by the Department of Sports and the Ministry of Education of the province

of La Pampa, a sample made up of children born in 2005 who were attending school in any of the 15 most populous districts in that province was established. Thirty public and private schools that agreed to participate were assessed, which had been randomly selected. Included students accounted for, overall, 15.3 % of the total for the province (as per the National Population Census of 2010, the universe included 5404 students) and represented the different regional realities. The minimum sample size was estimated to assess at least 11 % of the total for the province (represented by at least 594 children), and this percentage was selected due to its feasibility and convenience. All subjects born in 2005 who agreed to participate, whose parents gave their consent and completed the Pediatric Sleep Questionnaire (PSQ) at home, were included. Subjects who did not attend the anthropometric assessment on the expected date were excluded. The study ethical and methodological aspects were assessed and approved by the authorities of the Ministry of Social Welfare and the Ministry of Education. The protocol was approved by the Patagonian Independent Ethics Committee (Comité de Ética Independiente Patagónico, CEIP).

The procedure was performed by the principal investigators, who assessed anthropometric parameters. Participants' parents and/or caregivers completed the sleep questionnaire, which was sent the week prior to the assessment with the corresponding informed consent form, and was returned completed on the day of anthropometric data measurement at school.

Participants' demographic data (sex and date of birth) were obtained from the provincial education system database.

Anthropometric assessment

Weight was recorded in kg using a digital scale (Tanita BF 350®) with a 10 g precision and height, in cm using a portable stadiometer with a 1 mm precision. Body mass index (BMI) was estimated (weight in kg/height^2 in m) and used to classify patients into normal weight, overweight, and obese according to the International Obesity Task Force guidelines.[5] Waist circumference was measured at the umbilical level, at the end of a normal expiration, using a non-extensible tape measure with a 1 mm precision. Neck circumference was measured both in males and females just below the thyroid cartilage, above the laryngeal prominence, with the subject in standing position and their head adjusted to the Frankfurt plane; the observer was standing in front of the subject or slightly to their side. Abdominal obesity was defined using the waist circumference cut-off points proposed by Fernández et al. based on sex and age,[6] whereas high neck circumference was defined according to the cut-off points proposed by Souza et al.[7]

BP assessment

BP was measured two times, after having the subject rest in sitting position for 5 minutes, with a 1-minute interval. The measurement was performed on the right arm, with the subject sitting down with their back against the back of the chair, using a validated digital sphygmomanometer (OMRON model 7121®). In order to identify subjects with high BP values, both BP recordings were averaged. HTN was defined if the systolic BP was ≥ 130 mmHg and/or diastolic BP was ≥ 80 mmHg.[8]

Parents or tutors received the PSQ, aimed at detecting the presence of SDB. Two additional questions were included about sleep hours in order to assess sleep time separately and another questionnaire aimed at assessing physical activity. Sleep hours were estimated based on the time referred by parents about the time their children went to bed and got up in the morning. Compliance with international physical activity guidelines was assessed using a questionnaire validated for the adolescent population,[9] which allows to estimate compliance or lack of compliance with the recommendation of at least 60 minutes of physical activity a day, and subjects who did not meet this criterion were considered to have a sedentary lifestyle. SDB was assessed with the PSQ, which is made up of 22 items and divided into 3 main domains: snoring (9 items), sleepiness (7 items), and inattentive/hyperactive behavior (6 items). An increased risk for SDB was defined if the score was 8 or higher. The questionnaire was validated in Spanish.[10] For this study, snorer was defined as an adolescent who answered "yes" to at least 1 of the 2 following questions in the PSQ: "Does your child snore more than half the time?" and "Does your child always snore?"

Statistical analysis

The SPSS software for Windows (version 17.0, SPSS Inc.®, Chicago, IL) was used. Data were expressed as mean ± standard deviation, except when otherwise specified, and analyzed using Student's t test. The association among outcome

measures was assessed using a χ^2 test and Fisher's exact test, or based on logistic regression, as applicable, or univariate or multivariate analyses. A value of $p < 0.05$ was considered statistically significant.

RESULTS

Out of 1017 subjects initially invited to participate in the study, 831 met the inclusion criteria. Of these, 5 were excluded due to an incomplete anthropometric assessment, so the analysis sample was made up of 826 adolescents. Their mean age was 13.12 ± 0.34 years. The general characteristics of the sample are shown in *Table 1*.

TABLE 1. *General characteristics of the sample (N = 826)*

Outcome measures	N	%
Sex		
Male	377	45.6
Female	449	54.4
Weight category		
Thinness	39	4.7
Normal weight	422	51.1
Overweight	216	26.2
Obesity	149	18.0
Abdominal obesity	140	16.9
High neck circumference	146	17.7
Hypertension*	104	12.6

*The classification of hypertension is only for epidemiological assessment purposes. The diagnosis of this condition requires an assessment at different time points.

The average number of reported sleep hours was 8.7 ± 1.4. There was a tendency towards a higher presence of obesity in subjects who sleep less than 8 hours, although it was not statistically significant (Pearson's χ^2 test: 3.334; odds ratio: 1.447; $p = 0.07$).

It was observed that 58 out of 826 students (7 %) had values indicative of SDB, and no significant differences were observed between sexes (males: 5.8 % versus females: 8 %). In turn, 9.7 % of subjects were considered snorers, without differences between sexes (males: 10.4 % versus females: 9.1 %).

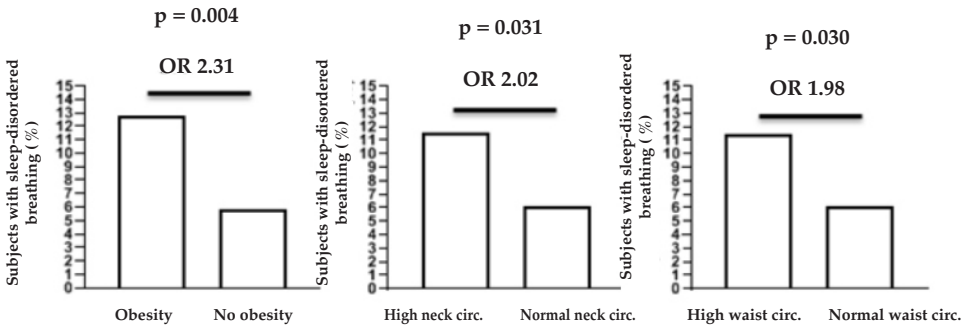
There was a higher prevalence of SDB and snoring among obese students, with an evident and significant association between these conditions. At the same time, both a high waist circumference and a high neck circumference were associated with a higher presence of SDB and snoring (*Figures 1* and 2).

Table 2 shows the main results of the logistic regression model used to assess the factors associated with the presence of HTN in adolescents. Both obesity and reduced sleep hours have a positive and statistically significant association with the presence of HTN. In turn, there was a positive association between a sedentary lifestyle and HTN, although it was not statistically significant ($p = 0.051$). There was no evidence of a significant relation between sex and BP or between SDB and HTN.

DISCUSSION

Few studies in the worldwide and Argentine bibliography have been published about SDB and snoring in adolescents. Based on our data, it was observed that the average reported

FIGURE 1. *Association between sleep-disordered breathing and obesity and waist and neck circumference in adolescents (N = 826)*



sleep hours was 8.7 ± 1.4, and that 24.6 % of assessed subjects did not meet the international recommendations of 8 hours or more of sleep per day.[11] Also, 7 % of adolescents had SDB. This result is higher than the 0-5.7 % prevalence described in the bibliography.[12-14] Data of a higher prevalence in adolescents than in children suggest that at least part of the increase of SDB symptoms in adults may start in this stage of life.

There is no universally accepted definition of snoring. In practice, parental perception is the gold standard for diagnosis.[15] In studies that asked whether snoring occurred always, prevalence was 1.5-6.2 %; and when asked if it occurred frequently, prevalence was 3.2-14.8 %.[15,16] The prevalence of snorers in this sample was 9.7 %, consistent with the ranges described in the bibliography.

Among adults, the prevalence of OSAS is affected by obesity.[17] The controversy of such association persists in children and adolescents. The NANOS study introduced the concept that pediatric obesity is a major risk factor for SDB.[18] In their studies, Ma et al. and Redline et al. found the same association.[19,20] This study found a significant association between obesity and SDB. Patients with obesity were more than two times more likely to be snorers or have SDB. A limitation of this observation is that there are no objective data available about adenotonsillar hypertrophy;[1,12] but it has also been described that, with the reduction of lymphatic tissue due to aging, obesity plays a more relevant role.[21,22] Phenotypic and etiologic differences in these 2 age groups may explain such findings.

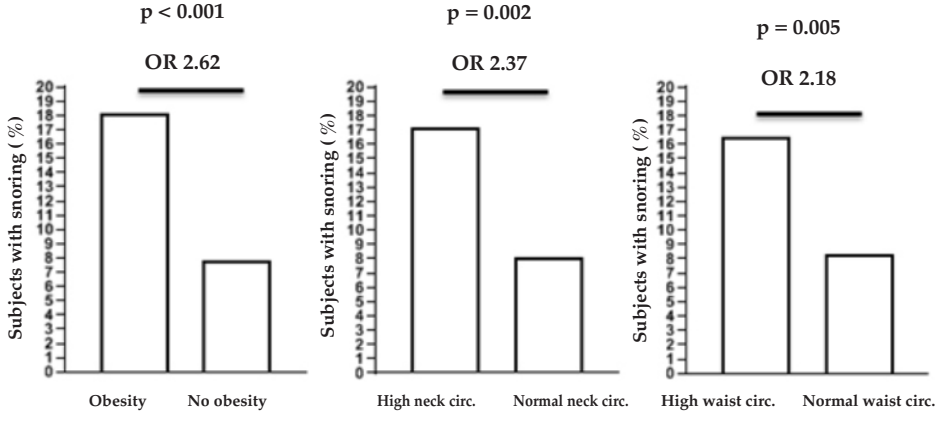
Fat deposits around the airways may cause snoring in the obese population.[15] In the NANOS study, 50 % of parents reported snoring in a population of obese adolescents, and this value increased to 70 % once a polysomnography was done.[18] Ma et al. found a significant association between weight and snoring in adolescents.[19] Consistent with this evidence, this study found a significant association between obesity and snoring, as snoring was reported by 18.2 % of the

TABLE 2. *Results of a logistic regression model to predict hypertension in adolescents based on different factors*

Predictors	Beta	Exponencial beta	95 % CI	*p* value
Male sex	0,310	1,364	0,878-2,118	0,167
Sedentary lifestyle	0,464	1,590	0,997-2,535	0,051
Sleep hours	-0,170	0,844	0,715-0,995	0,044
Obesity	1,570	4,710	3,002-7,389	< 0,001
Sleep-disordered breathing	0,401	1,494	0,725-3,080	0,227

CI: confidence interval.

FIGURE 2. *Association between snoring and obesity and neck and waist circumference in adolescents (N = 826)*



obese population versus only 7.8 % of non-obese subjects.

The increase in neck size in adults is a predictor of OSAS. Glicksman et al. observed that the percentage of neck fat mass in children was associated with the severity of OSAS.[23] In this study, a significantly higher neck circumference was observed in subjects with SDB and snoring.

In adults, waist circumference is a risk factor for the development of SDB. In adolescents, information is contradictory. Canapari et al. and Danisi et al. demonstrated that waist circumference is associated with an increased risk for SDB in adolescence.[24,25] On the contrary, Verhulst et al.[26] reported that SDB was independent from waist circumference. In this study, waist circumference was significantly associated with the presence of SDB and/or snoring.

Risk factors for cardiovascular disease start during childhood and may continue in adulthood.[27] A systematic review of published studies conducted in children and adolescents in Argentina showed that the prevalence of HTN was 7.35 % and higher in adolescents than in children aged 10 years or younger.[28] In this study, the prevalence of HTN was 12.6 %, which is higher than what has been reported to date. It is important to note that, in 2017, the American Academy of Pediatrics reviewed the definition of HTN, and such definition was adopted by the *Sociedad Argentina de Pediatría* in 2019;[8] therefore, the prevalence of prehypertension and/or hypertension in children and adolescents may have changed.

Although multiple factors affect BP in both children and adolescents, there is evidence of the role of obesity in the increased prevalence of HTN in recent decades.[29,30] This study found a significant association between HTN and obesity.

It has been described that 50 % of adults with resistant HTN develop OSAS. In adolescents, different studies have evidenced that the presence of OSAS may be associated with increased BP.[27] However, in this study, it was not possible to establish a significant association between HTN and SDB, but this may be due to the lack of statistical power to detect such association in the studied sample.

Sociocultural changes, the increase in school and out-of-school activities, electronic device use, and the culture of a permanent online presence have turned adolescents into a vulnerable population both in relation to the reduction in sleep hours and poor sleep quality.[31] It has been demonstrated that poor sleep has an effect on the etiopathogenesis of obesity and HTN.[32,33] This study did not establish an association between sleep hours and obesity. However, a positive association was observed between reduced sleep hours and HTN. This is consistent with a recent meta-analysis,[34] and highlights the duration of sleep as a factor capable of regulating cardiovascular risk in children and adolescents.

This study has some limitations. The most important limitation is that the PSQ was used to detect the presence of SDB instead of a polysomnography, which is the gold standard procedure.[2,35-37] Another limitation is that there were no data available about adenotonsillar hypertrophy; therefore, it was not possible to establish a relationship between its presence or absence and snoring and SDB.

Notwithstanding this, it was possible to estimate the prevalence of SDB and snoring in adolescents in Argentina.

CONCLUSIONS

This study estimated that the prevalence of SDB and snoring in a population of adolescents (mean age: 13 years) was 7.0 % and 9.7 %, respectively. SDB and snoring were more prevalent among adolescents with obesity. A reduction in sleep hours and the presence of obesity were significantly associated with higher BP recordings. This study conducted in Argentine adolescents allows to establish the epidemiological factors that may be potentially reversed with an adequate and timely management. ■

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