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Obstructive Sleep Apnea-Hypopnea Syndrome in Children Is Not Associated With Obesity

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OBJECTIVE: The prevalence of obstructive sleep apnea-hypopnea syndrome (OSAHS) in the general pediatric population ranges from 1% to 3%. However, its prevalence in an unselected population of obese children is unknown. We studied the association between obesity and OSAHS in children diagnosed with the syndrome in a cohort of boys and girls (age range, 2-14 years) referred to the pediatric respiratory medicine outpatient clinic at our hospital for suspected apnea, snoring, or both over the past 5 years.

PATIENTS AND METHODS: The medical history of each patient was recorded and all patients underwent a physical examination, chest and nasal cavities radiography, and 8-channel respiratory polygraphy during sleep. The following variables were evaluated: sex, reason for consultation, source of referral, findings during upper airway examination, age, weight *z*-score (reflecting how much a finding differs from the mean and in what direction in a normally distributed sample), height *z*-score, body mass index (BMI) *z*-score, number of apneas, number of hypopneas, apnea index, hypopnea index, apnea-hypopnea index (AHI), oxygen saturation (mean and minimum) measured by pulse oximetry, number of snores, and snore index.

RESULTS: Of the 400 patients studied, 242 (60.5%) were male and 158 (39.5%) female. The mean age was 4.95 years. OSAHS (AHI≥3) was diagnosed in 298 cases (74.5%) and these patients were then studied to determine the relation between OSAHS and obesity. The anthropometric distribution (expressed as mean [SD]) was as follows: weight *z*-score, 0.37 (1.31); height *z*-score, 0.23 (1.19); BMI, 17.063 kg/m^2 (2.51); and BMI *z*-score, 0.39 (1.36). The respiratory polygraph during sleep recorded an AHI of 6.56 (7.56).

CONCLUSIONS: No differences were observed between the height *z*-score, weight *z*-score, BMI *z*-score, age, and AHI. No association between obesity and OSAHS was found in this series. However, studies of larger, unselected populations are needed to determine if obesity is a risk factor for OSAHS in children.

Key words: *Obstructive sleep apnea-hypopnea syndrome. OSAHS. Obstructive apneas. Obesity. Children.*

El síndrome de apneas-hipopneas obstructivas durante el sueño en niños no se asocia a obesidad

OBJETIVO: El síndrome de apneas-hipopneas obstructivas durante el sueño (SAHOS) alcanza una prevalencia del 1-3% en población general infantil. Sin embargo, en población obesa no preseleccionada la prevalencia es desconocida. Para estudiar la asociación entre SAHOS y obesidad en niños diagnosticados de dicho trastorno, hemos analizado a una cohorte de niños y niñas (2-14 años) remitidos en los últimos 5 años a consulta externas de neumología infantil por sospecha de apneas durante el sueño, ronquido o ambos.

PACIENTES Y MÉTODOS: A los pacientes incluidos se les realizaron anamnesis, exploración física, radiografía de tórax y cávum y poligrafía respiratoria durante el sueño con 8 canales. Se analizaron las siguientes variables: sexo, motivo de consulta, procedencia, exploración de la vía aérea superior, edad, z-*score* del peso (cuánto se desvía la media de peso y en qué dirección respecto de la media de peso de una distribución normal), z-*score* de la talla (cuánto se desvía la media de la talla y en qué dirección respecto de la media de la talla de una distribución normal), z-*score* del índice de masa corporal (IMC; cuánto se desvía la media del IMC y en qué dirección respecto de la media del IMC de una distribución normal), número de apneas, número de hipopneas, índice de apneas/h, índice de hipopneas/h, índice de apneas-hipopneas/h (IAH/h), saturación de oxígeno por pulsioximetría (media y mínima), número de ronquidos e índice de ronquidos/h.

RESULTADOS: Se estudió a 400 pacientes, con una edad media de 4,95 años, de los que 242 eran varones (60,5%) y 158 niñas (39,5%). Se diagnosticó de SAHOS (IAH/h ≥ 3) a 298 (74,5%), y en éstos se analizó la relación entre SAHOS y obesidad. La distribución antropométrica (expresada en media ± desviación estándar) fue la siguiente: z-peso de 0,37 ± 1,31; z-talla de 0,23 ± 1,19; IMC de 17,063 ± 2,51 kg/m^2, y z-IMC de 0,39 ± 1,36. Los resultados de la poligrafía respiratoria durante el sueño mostraron un IAH/h de 6,56 ± 7,56.

CONCLUSIONES: No se han encontrado diferencias entre z-talla, z-peso, z-IMC, edad e IAH/h. En esta serie la obesidad no se asocia a SAHOS. Sin embargo, se requieren estudios en poblaciones más amplias y no preseleccionadas para evaluar si la obesidad actúa o no como factor de riesgo para desarrollar SAHOS en niños.

Palabras clave: *Síndrome de apneas-hipopneas durante el sueño. Apneas obstructivas. Obesidad. Niños.*

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Introduction

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is common in children, with a prevalence of 1% to 3% in the general pediatric population.[1] In adults, obesity is a predisposing factor for developing OSAHS, although it is not clear that the same is true for children. In selected populations of at-risk children, the prevalence of OSAHS in obese and morbidly obese children has been reported as 0.7% to 5.7% and 13.3%, respectively; however, the prevalence of sleep-related breathing disorders, such as OSAHS, in an unselected obese pediatric population is unknown.[2-5] To clarify this situation, we studied a consecutive sample of boys and girls referred to the pediatric respiratory medicine outpatient clinic at our hospital for suspected apnea, snoring, or both over the past 5 years. The objective was to determine the possible association between OSAHS, which was diagnosed by respiratory polygraphy, and obesity.

Patients and Methods

We undertook a retrospective study of a cohort of boys and girls (age range, 2 to 14 years) referred by outpatient services from otorhinolaryngology, pediatric respiratory medicine, and primary care clinics for suspected apnea, snoring, or both from October 1998 through December 2004. A detailed medical history of each patient was recorded and all underwent a standard physical examination. The following characteristics were recorded: weight (kg), weight *z*-score (reflecting how much a score differs from the mean and in what direction in a normally distributed sample), height (cm), height *z*-score, body mass index (BMI; kg/m^2), and BMI *z*-score. These measurements were obtained using standard techniques (a single qualified observer using a stadiometer [Holtain, Cambridge, UK] and a scale [SECA, Hamburg, Germany]). The growth tables published by the Orbegozo Foundation were used to obtain standard height and weight growth percentiles.[6]

All patients underwent chest and nasal cavities radiography. Respiratory polygraphy (Sibelhome 300 [Sibel, Barcelona, Spain] and Apnoescreen Pro [Jaeger, GMBH, Wuerzburg, Germany]) was performed in all cases on an inpatient basis from 9 p.m. to 7 a.m., with a mean duration of 7 hours. The following variables were evaluated: oronasal airflow (recorded using a thermistor sensor), thoracic and abdominal movements (piezoelectric sensors), oxygen saturation in arterial blood (SpO_2) and heart rate (both measured by pulse oximetry), body position, and snoring (detected by polygraph). Muscle activity was monitored (Apnoescreen Pro) over the last 4 years of the study. The final reading was obtained through deferred manual analysis by a single observer over the course of the study period.

The following qualitative variables were analyzed in all cases: sex, reason for consultation (snoring, apnea, or both), source of referral (otorhinolaryngology, pediatric respiratory medicine, or primary care outpatient clinics), and findings from examination of the upper airways (tonsillar, adenoid, or adenotonsillar hypertrophy or normal structures). The following quantitative variables were also evaluated: weight *z*-score, height *z*-score, BMI *z*-score, number of apneas, number of hypopneas, apnea index, hypopnea index, apnea-hypopnea index (AHI), SpO_2 (mean and minimum), number of snores, and snore index. Central apneas were excluded from this study.

Obstructive apnea was defined as a decrease of 90% or more in oronasal airflow for at least 2 respiratory cycles in the presence of continued respiratory effort and accompanied by a 3% or greater decrease in SpO_2 levels. Obstructive hypopnea was defined as a decrease in airflow of more than 50% (measured by oronasal thermistor) for at least 2 respiratory cycles, accompanied by a decrease in SpO_2. OSAHS was considered mild (AHI, 3-5), moderate (AHI, 6-9), or severe (AHI, ≥10).[3-5, 7] Patients with a BMI above the 95th percentile for their age and sex were considered obese.[8,9]

Statistical Analysis

The Student *t* test was used to determine the association between sexes for weight, height, and BMI *z*-scores. A linear regression model was used to evaluate the association between weight *z*-score, height *z*-score, BMI *z*-score, age, and AHI. The correlations between mean SpO_2, minimum SpO_2, number of snores, and BMI *z*-score were also assessed.

Results

We evaluated a cohort of 400 patients referred to the pediatric respiratory medicine unit for respiratory polygraphy by the outpatient departments of otorhinolaryngology (n=159; 39.8%), primary care (n=145; 36.2%), pediatric respiratory medicine (n=70; 17.5%), and other departments (n=26, 6.5%). The mean (SD) age of this initial cohort was 4.95 (2.3) years; 242 were boys (60.5%) and 158 girls (39.5%). The reason for consultation was clinical suspicion of apnea in 191 cases (47.8%), snoring and apnea in 101 (25.2%), snoring in 87 (21.8%), and other complaints in 21 (5.2%) (Table 1).

Of the 400 patients evaluated, OSAHS (AHI≥3) was diagnosed in 298 (74.5%). All patients diagnosed with OSAHS (n=298) were evaluated to determine the relation between OSAHS and obesity. The mean AHI, as measured by respiratory polygraph, was 6.5 (7.5)

TABLE 1
Descriptive Characteristics of the Cohort Studied*

	N	%
Sex		
Male	242	60.5
Female	158	39.5
Source of referral		
Pediatric respiratory medicine	70	17.5
Otorhinolaryngology	159	39.8
Primary care	145	36.2
Other	26	6.5
Reason for consultation		
Suspected of apneas	191	47.8
Snoring	87	21.8
Apnea and snoring	101	25.3
Other	21	5.2
Findings from otorhinolaryngology examination†		
Adenoid hypertrophy	73	18.2
Tonsillar hypertrophy	87	21.8
Adenotonsillar hypertrophy	211	52.8
Normal	28	7
Anthropometry		
Weight *z*-score >2 SD	35	13.8
Height *z*-score >2 SD	32	14.8
BMI *z*-score >2 SD	34	15

*BMI indicates body mass index.
†Findings for 1 patient were unavailable.

(Table 2). The anthropometric distribution of the sample was as follows: weight *z*-score, 0.3 (1.3); height *z*-score 0.2 (1.1); BMI, 17 (2.5); and BMI z-score, 0.3 (1.3) (Table 3).

Of the 298 cases (74.5%) diagnosed with OSAHS, full anthropometric measurements (weight *z*-score, height *z*-score, BMI *z*-score, and BMI) were recorded in 255 (85.6%). However, anthropometric data was incomplete in 43 subjects (14.4%).

No significant differences between males and females were found in the z-scores for weight, height, or BMI (Table 4). Likewise, no association was found between the height *z*-score (correlation coefficient, r=0.08), weight *z*-score (r=0.06), BMI *z*-score (r=0.07), age (r=0.006), or AHI. Nor was any relation found between mean SpO_2 (r=0.01), minimum SpO_2 (r=0.08), number of snores (r=0.006), or BMI *z*-score.

TABLE 2
Results of Respiratory Polygraphy

Variable	Mean (SD)
Number of apneas	26 (23.5)
Number of hypopneas	25 (21.1)
Apnea index	3.1 (2.8)
Hypopnea index	2.9 (2.5)
Apnea-hypopnea index	6.5 (7.5)
Mean oxygen saturation	95.6 (5.7)
Minimum oxygen saturation	83.5 (10)
Number of snores	93.1 (263.9)
Snore index	5.5 (6)

TABLE 3
Anthropometric Distribution of Cohort Studied: Weight, Height, and BMI Z-Scores*

Variable	Mean (SD)
Weight *z*-score	0.3 (1.3)
Height *z*-score	0.2 (1.1)
BMI *z*-score	0.3 (1.3)
BMI	17 (0.3)

*BMI indicates body mass index.

TABLE 4
Distribution of Anthropometric Variables According to Sex*

Variable	Category	N	Mean (SD)	*P*
Height *z*-score	Male	132	0.3 (1.1)	NS
	Female	94	0.1 (1.2)	NS
Weight *z*-score	Male	150	0.3 (1.3)	NS
	Female	103	0.4 (1.2)	NS
BMI *z*-score	Male	132	0.3 (1.3)	NS
	Female	94	0.5 (1.3)	NS

*NS indicates not significant.

Discussion

OSAHS is very common in children and adults, with a prevalence that ranges from 1%-3% in children and 2%-4% in adults.[10] Adenotonsillar hypertrophy is the most common cause of OSAHS in childhood. Other causes include neuromuscular diseases (types 1 and 2 Arnold-Chiari malformation, myotonic dystrophy, and several myopathies) and craniofacial anomalies (microretrognathia, Gothic palate, and Down, Apert and Crouzon syndromes). In addition, several proinflammatory factors—such as C-reactive protein, tumor necrosis factor (TNF) α, and interleukin 6 (IL-6), all of which produce local inflammation of the airway mucosa—may contribute to airway obstruction and may also, therefore, play a significant role in the etiopathogenesis of this clinical entity in children.[11-13]

The prevalence of obesity and overweight has risen in the last 10 years, by approximately 10% in the United States of America, where studies show that between 0.1% and 4% of children aged 2 to 18 years are obese and 5% to 18% are overweight.[14,15] Recently, Cole et al[16] proposed a new definition for obesity and overweight in children. They developed BMI tables that can predict obesity (defined as BMI>30 kg/m^2) and overweight (BMI>25 kg/m^2) at age 18, based on international data for children aged 2 to 18 years. The use of international standards for measuring obesity and overweight is less arbitrary and, as a result, allows for international comparisons between various populations.

Although the association between obesity and OSAHS in adults has been widely described, the prevalence of OSAHS among obese children is highly variable.[17,18] Although obesity is not considered a clear predictor of OSAHS in children, it has been reported to be associated with snoring and transitory nocturnal oxygen desaturation.[19] On the other hand, the increase in pediatric obesity is associated with illness characteristic of adulthood: an increase in type 2 diabetes mellitus, insulin resistance, hypertension, lipid metabolic disorder, and heart disease. Adults with sleep-disordered breathing have elevated levels of C-reactive protein and other inflammatory markers (IL-6 and TNF-α) that have implications for cardiovascular comorbidity and atherogenesis; however, these findings have not been confirmed in children.[20]

A recent study described elevated C-reactive protein level to be associated with a higher AHI and a decrease in SpO_2 during sleep in children with a high BMI and sleep-disordered breathing.[21] These findings suggest that obesity could be considered a chronic inflammatory condition. Some authors have proposed distinguishing between OSAHS caused by adenotonsillar hypertrophy (generally described in children who are underweight for their age) and OSAHS in adolescents and obese children, whose pattern of disease more closely resembles that of OSAHS in adults.[22]

Marcus et al[23] described a positive correlation between obesity and AHI and a negative correlation between obesity and oxygen saturation during sleep. That study found an increase in the prevalence of sleep-disordered breathing in the obese children studied. Nevertheless, since the sample consisted of obese preadolescents (mean age, 10 years), it may not be representative of the general pediatric population but rather behave like a population of young adults. This would mean that the prevalence of sleep-disordered breathing in an unselected population of obese children is still unknown.[5]

According to McNamara and Sullivan,[18] obesity in childhood is not the risk factor for developing OSAHS that it is in adults; in very young children, however, obesity may sometimes be associated with delayed growth. The findings of Rosen,[24] who evaluated the clinical characteristics of children diagnosed with OSAHS by polysomnography, were similar. That study found no association between sex or obesity and AHI even though the incidence of obesity in the study population was double that of the general pediatric population.

In our cohort, obesity was not associated with OSAHS (AHI), the number of snores, mean SpO_2, minimum SpO_2, or sex. Our study enrolled children diagnosed with OSAHS and referred for respiratory consultation for suspected apnea and/or snoring by outpatient otolaryngology and primary care clinics. As a result, our series of patients was not representative of the general pediatric population, and this was a limitation of our study.

However, anthropometric data from our series indicates that the children we studied were heavier (13.8% had a weight *z*-score >2 standard deviations above the mean) and more obese (15% had a BMI *z*-score >2 standard deviations above the mean) than the general pediatric population used as a reference for the growth tables created by the Orbegozo Foundation in 2004 (Table 1). Therefore, obesity does not appear to be related to OSAHS, although studies of the general pediatric population would be necessary to determine whether or not obesity is a risk factor for developing this disease.

Chng et al[25] recently described the association between habitual snorers and obesity (odds ratio [OR], 3.7; 95% confidence interval [CI], 1.68-4), allergic rhinitis (OR, 2.9; 95% CI, 2.06-4.08), and atopic dermatitis (OR, 1.8; 95% CI, 1.2-2.5). The odds ratio of a child with these 3 diseases being a snorer is 7.4 (95% CI, 3.4-15.9). Similarly, Suilt et al[26] have reported a significant association between obesity, respiratory wheezing, and asthma.

Polysomnography is the gold standard diagnostic test for pediatric OSAHS.[5,7] However, due to the technical and economic difficulties involved in polysomnography, alternative diagnostic techniques have been proposed. One such technique is respiratory polygraphy during sleep, a technique validated in adults for the diagnosis of OSAHS (sensitivity, 97%; specificity, 90%), although validation for use in children is pending.[27-29] Although respiratory polygraphy may underdiagnose hypopnea, missing some episodes, it is considered an adequate screening technique for the study of pediatric OSAHS.[3,30-33] However, because respiratory polygraphy can give false negatives, polysomnography should be performed when clinical suspicion is high, even if results from the polygraph are negative. In Spain, such patients are referred for the study of sleep-disordered breathing to our sleep laboratory at the Hospital Txagorritxu in Vitoria, Spain. In summary, we can state that childhood obesity was not associated with OSAHS in our series. However, studies of larger, unselected populations are required to continue evaluating the association between obesity and sleep-disordered breathing during childhood.

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