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Sleep quality of healthy schoolchildren: report of five cases

Qualidade do sono de escolares saudáveis: registro de cinco casos

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ABSTRACT: *Background:* sleep quality is a fundamental aspect of children's development, and its alteration could lead to pathologic events, which compromise the quality of life and child's development. *Objective:* This study aimed to present the polygraphy data recorded during the sleep of healthy children. *Method:* participated five healthy schoolchildren. Sleeping was assessed through the Sleep Behavior Questionnaire (SBQ) and home nocturnal polygraphy (HNP). In addition, there were collected anthropometric and spirometric data, and it was applied The International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire. *Results:* The children showed a mean age of 10.8±1.78 years old (1 boy) and a mean BMI of 18.94±2.45 kg/m^2. The mean sleeping time recorded in HNP was 430 minutes (7.1 hours), with mean oxygen saturation of 95.8% and mean heart rate of 64.3 bpm. The apnea-hypopnea index (AHI) varied between 2 and 4.3 per hour (mean of 2.9), and when analyzing only the events in the supine position, the AHI mean was 3.38. All children presented snoring at night, varying from four to 63 snoring episodes/night. SBQ showed a mean of 42.8 points, suggesting mild sleep disorders, in addition to the presence of snoring, although the children were healthy. *Conclusion:* the healthy children evaluated in this study presented symptoms indicating respiratory sleep disturbance such as mild sleep apnea.

Keywords: Child, Sleep; Diagnosis; Polygraphy; Sleep apnea syndromes

RESUMO: *Introdução:* a qualidade do sono é um aspecto fundamental do desenvolvimento infantil, pois quando prejudicada, pode ter como consequência eventos patológicos que acometem a qualidade de vida e o desenvolvimento da criança. *Objetivo:* apresentar o registro de dados da poligrafia durante o sono de um grupo de escolares hígidos. *Metodologia***:** relatou-se o registro de cinco casos de escolares saudáveis que foram avaliados por meio de poligrafia noturna domiciliar (PND) e o questionário *Sleep Behaviour Questionaire* (SBQ). Também foi realizada antropometria, espirometria e aplicado o questionário *International Study of Asthma and Allergies in Childhood (ISAAC)*. *Resultados*: a idade média dos casos analisados foi de 10,8±1,78 anos (1 menino) e o índice de massa corporal (IMC) 18,94±2,45 cm/m^2. O tempo médio de registro na PND foi de 430 minutos (7,1 horas), com média de saturação de pulso de oxigênio de 95,8%, e frequência cardíaca de 64,3 bpm. O índice de apneia e hipopneia (IAH) variou entre 2 e 4,3 por hora (média de 2,9/hora) e, quando analisados somente os eventos na posição supina, a média do IAH foi de 3,38/hora. Todas as crianças apresentaram ronco noturno, com grande variação entre elas (4-63 episódios de roncos/ noite) e o SBQ pontuou valor sugestivo de distúrbio respiratório do sono (DRS) de caráter leve (média de 42,8 pontos). *Conclusão*: os escolares hígidos analisados manifestaram sintomas e indicativos de DRS, como apneia do sono leve, segundo os instrumentos utilizados.

Palavras-chave: Criança; Sono; Diagnóstico; Poligrafia; Síndromes da apneia do sono.

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INTRODUCTION

There are the following methods to monitor sleeping: Type I - it is considered the gold standard because it is complete with more sensors to evaluate sleep than the other ways of monitoring. It needs to be performed in a clinical facility and requires a specialized team. Type 2 – it is performed in residence, presents seven monitoring channels, at least, and requires a professional to install and recall the device, and it does not require a specialized team during the evaluation. Type 3 – it is known as cardiorespiratory monitoring or home nocturnal polygraphy (HNP); it has four to seven channels and, it is possible to identify and differentiate respiratory events. The patient can adjust the sensors on their own. Type 4 – it has one to two channels; one of them is oximetry, and it identifies desaturation. This way of sleep monitoring does not differentiate types of apnea and sleeping phases[1].

Regarding the pediatric population, sleep disorders (SD) can be associated with autism spectrum, attention deficit, hyperactivity[1] and, respiratory diseases such as asthma, rhinitis, and cystic fibrosis[2–4]. Among the SD, there is the Obstructive Sleep Apnea (OSA), a respiratory disturbance characterized by upper airway obstruction followed by hypoxemia and sleeping fragmentation[5].

Sleep-related breathing disorders are prevalent in children, just as in asthma, even though symptoms manifestations are slow and even late[6]. Therefore, it is important to investigate, under different aspects, complaints concerning sleep in children once OSA diagnosis is made by clinical history and physical exam. Questionnaires can complement the physical exam besides sleeping monitoring through polysomnography or polygraphy[2,5,7]; for instance, type 3 monitoring.

Therefore, this study aimed to present the polygraphy data recorded during the sleep of healthy children.

METHOD

This is a descriptive study reporting cases of schoolchildren living in Balneário Camboriú city – SC/ Brazil. The children were between nine to 13 years old, oriented and collaborative, without respiratory, neuromuscular, or musculoskeletal diseases. Children who were obese, athletes enrolled in sports federations, or unable to perform the proposed assessment procedures did not participate in the study. This study was approved by the Santa Catarina State University (UDESC) ethics committee (CAAE: 61341816.2.0000.0118).

Data collection started after the guardians and the children signed the Informed Consent Term and Minor Informed Assent Term. Then, the guardians filled in the children's health record, which the authors elaborated; module I of the International Study of Asthma and Allergies in Childhood (ISAAC), validated to the Portuguese language[8]; and Sleep Behavior Questionaire (SBQ)[9], validated to the Portuguese language. Moreover, anthropometric data, spirometry, and two measurements of HNP were registered.

The children's health records collected information regarding socioeconomic factors, health-related habits, children's exposure to cigarette smoke, hours of sleep, and hospitalizations. Module I of the ISAAC questionnaire was used to identify the presence of asthma, and the following cut-off points were used: more than five points to children between six to nine years old, and more than six points to children between ten to 14 years old[10]. Anthropometric measures such as weight in kilogram (scales brand ISP®, São Paulo/Brazil) and height in meters (stadiometer brand Filizola®, São Paulo/Brazil) were collected; then, the body mass index (BMI-kg/m^2) was calculated.

Spirometry was used to sample characterization once its parameters analysis identify alterations in lung function even in the absence of symptoms or respiratory condition diagnosis. This evaluation aims to measure, in one forced maneuver, the maximum volume in inspiration and expiration; therefore, this exam assesses lung function, airway responsiveness, and diseases course.[11] The spirometry was performed in the Easy One Frontline portable device (ndd Medical Technologies, Inc. EUA), according to the American Thoracic Society (ATS) recommendation[11]. There were conducted three forced expiration maneuvers, and the best one was registered for analysis. The following spirometric parameters were considered: forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), FEV1/FVC ratio, and forced expiratory flow over the middle one half of the FVC ($FEF_{25-75\%}$); data were presented in predicted percentage according to Polgar et al.[12] and Knudson et al.[13].

SBQ assessed behavior during sleep in the last six weeks and was divided into five factors: parasomnias, parent/child interaction during nighttime difficulties, sleep fragmentation, daytime sleepiness, and bedtime. Each item received a score from one (never) to five (always), and the final score may vary between 26 to 130 points. The higher the final score, the higher are the probability of sleep problems and the presence of SD[9].

Regarding the HNP evaluation, the children and their guardians received verbal directions, demonstration of equipment assembly, illustrative orientation regarding equipment installation, and personal routine for the evaluation. The device was adapted at children's homes before sleeping time. The parameters obtained were:

nasal flow, thoracic effort, oxygen saturation (SpO2), heart rate (HR), sleep position, and night registration time. The minimum sleep time recorded was two hours and 30 minutes, and the maximum time was 12 hours. The HNP was conducted for two consecutive sleeping nights; for analysis, the longer sleeping night record was chosen with better sensors signals, which was checked by STARDATA program (Philips Respironics – USA). Sensors' signals were simultaneously analyzed in periods of 15-second during the whole recording. There were registered data of obstructive sleep apnea (OSA), central sleep apnea (CSA), mixed apnea (MA), hypopnea (HY), in supine and non-supine positions, and apnea-hypopnea index (AHI) classified according to Pessoa et al.[14], showed in the chart. The Excel program was used to organize the data, descriptive analysis was performed and presented as table, means, and standard deviations.

Chart. Diagnose classification according to apnea-hypopnea index (AHI)[14]

DIAGNOSE	AHI
Primary Snoring	≤ 1
Upper airway resistance syndrome	≤ 1
Mild OSA	1 – 5
Moderate OSA	5 – 10
Severe OSA	>10

Legend: AHI: apnea-hypopnea index; OSA: Obstructive Sleep Apnea.

RESULTS

Five students participated in the study, four female, with a mean body mass of 41.02±12.52 kg and height of 1.45±1.20m, of which four were considered eutrophic, and one was overweight. The table presents the sample characterization data, spirometric parameters, and HNP.

Table. Presentation of the characterization data of each individual in the group of 5 studied cases.

Case	Age (years)	Gender	BMI (kg/m2)	FVC (%)	FEV_1 (%)	FEV_1/FVC (%)	FEF_{25-75} (%)	ISAAC
1	13	M	21,0	108,6	101,9	101,1	107,0	4,0
2	9	F	17,2	74,0	69,0	93,0	19,0	2,0
3	11	F	22,0	84,0	76,0	91,0	84,0	≤0,05
4	12	F	18,1	97,0	84,0	86,0	103,0	2,0
5	9	F	16,3	93,6	93,8	96,6	70,0	2,0
M±SD	10,8±2,8	-	18,9±2,5	91,4±13,1	84,9±13,2	93,5±5,7	76,6±35,5	-
Case	**AHI**	**CSA**	**OSA**	**MA**	**HY**	**SNORING**	**ODI**	**Mean HR**
1	4,3	3,0	8,0	0	19,0	30,0	4,3	56,8
2	2,0	4,0	6,0	0	8,0	63,0	41,8	65,0
3	2,0	1,0	6,0	0	2,0	4,0	1,7	65,3
4	2,6	7,0	11,0	0	6,0	17,0	5,9	66,0
5	3,9	7,0	6,0	0	11,0	4,0	2,6	68,6
M±SD	3,0±1,1	4,4±2,6	7,4±2,2	-	9,2±6,4	23,6±24,5	11,3±17,1	64,3±4,4

Legend: BMI: Body Mass Index; Kg/m²: kilogram per square meter; FVC: forced vital expiratory capacity; FEV_1: forced expiratory volume in one second; FEV_1/FVC: relation between forced expiratory volume in one second and forced vital expiratory capacity; FEF_{25-75}: forced expiratory flow between 25–75% of FVC; %: predicted percentage; AHI: apnea- hypopnea index per hour; CSA: central sleep apnea; OSA: Obstructive sleep apnea; MA: mixed apnea; HY: hypopnea; HR: heart rate; ISAAC: International Study of Asthma and Allergies in Childhood; ODI: oxygen desaturation index; Snoring: snoring episodes at night; CSA, OSA, MA, HY and Snoring data presented in total number of events during the night.

The final SBQ score varied between 29 to 52 points; of 130 possible points, the only boy in the sample had the lowest score. The mean SBQ score of the studied population was 42.8 points.

The HNP mean time was 430 minutes (7.1 hours), with the students staying 61.3% of the total time in the supine position. The AHI values varied between two to 4.3/hour (mean of 2.9/hour), and when only the supine position events were analyzed, the mean of the AHI was 3.38/hour. All the participants showed events of CSA (0.2 – 1.1/night), HY (0.7 – 2.7/night) and OSA (0.7 – 1.4/night). None of the individuals showed MA.

The mean SpO_2 was 95.8%, and HR was 64.3bpm during the night. All the students presented nocturnal snoring, with a high variation (4-63 snoring episodes per night) (Table). Child number 2 (Table) showed FEV_1 below

70% of predicted, and in the HNP, he showed the highest number in the desaturation index; in addition to being the only one with SpO_2 below 88% and the highest number of snoring.

DISCUSSION

This study reports five cases, and despite using a small sample group, it identified the presence of airway resistance detected through the HNP in supine and non-supine positions. The finding of mild sleep apnea[14] in the present study population encourages future research, with larger sample groups, as a method for early SD diagnosis, even in children with no respiratory conditions.

In this context, the present study showed that the child (case 2) with the lowest FEV_1 - less than 70% of the predicted value - was the individual who desaturated during the HNP and with the highest record of snoring. Therefore, the relevance of understanding the relation between FEV_1 and sleeping parameters in the pediatric population is verified, especially in respiratory diseases such as asthma, cystic fibrosis, rhinitis, and even mouth breathers.

Corroborating this information, the literature[4] shows that both adults and children with cystic fibrosis seem to report a direct correlation between disease severity, evaluated by FEV_1, and SpO_2 behavior during sleeping. Concerning asthma, a study used questionnaires and actigraphy to evaluate the children's sleep and identified that FEV_1% lower values, measured at night, were associated with lower sleep efficiency during the subsequent nocturnal sleep period and that lower nocturnal values of FEV_1 were related to a higher number of nocturnal awakenings.[3] However, a better understanding of this relationship is still needed in other respiratory conditions and children without respiratory diseases.

Regarding sleep monitoring, the gold standard for OSA diagnosis is PSG type I, which requires monitoring in a controlled laboratory environment, and it is a costly exam[15,16]. Therefore, a more viable and practical alternative for sleep evaluation is the HNP, which is able to measure a typical night sleep at home[15,16]. In Tan et al.[15] review, the authors showed that type II (unsupervised) and type III monitoring are an alternative for sleeping assessment in children, with an efficacy of 90% of the reports. In the present study, the efficacy was verified through the minimum time of registration and the presence or absence of artifacts.

In Montgomery-Downs et al.[17] study, PSG type I data from 542 healthy children aged three to seven years old were described. The mean AHI for the younger children (three to five years) was 0.9, and for the older children (six to seven years) was 0.68. Although there was no significant difference between age groups, the authors reported that there was a tendency to reduce AHI in older children. When comparing these findings with the current study, the AHI here was higher than the mean presented by Montgomery-Downs[17] and showed a higher mean age (about nine years). In this context, the importance of identifying and treating all cases early is highlighted, given that children with SD, even in their mild forms, are at risk of manifesting cognitive and academic defficits[2].

To perform OSA diagnosis, besides monitoring the sleep directly, the individual's clinical condition must also be considered for analysis to associate it with the exam; for this purpose, the SBQ questionnaire was also applied in this report. This questionnaire evaluates sleep behavior in the pediatric population[9], and in the current research, children showed a mean score that indicates a low probability of changes in sleep behavior, what do not corroborate the HNP findings. However, a limitation of this questionnaire is that there are no cut-off points that make it possible to classify sleep.

All the information discussed here highlights the necessity to conduct longitudinal follow-up studies with larger pediatric samples, which will allow the identification of risks for SD and the repercussions on children's development, both healthy and those with respiratory diseases. In addition, the vulnerability of this population to SD must be investigated, reinforcing the importance of sleep assessment in this age group.

CONCLUSION

The present study reports five cases showing that schoolchildren, even healthy, presented mild breathing sleep disorder and episodes of nocturnal snoring, which instigates further research on sleep quality assessment in this population.

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