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Research Article

Reported Symptoms of Obstructive Sleep Apnea in a Group of Saudi Children

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ABSTRACT:

Objective: To report the most commonly experienced night and daytime behavior and symptoms by a group of Saudi OSA children and compare them with a healthy control. Methods: 27 mothers of OSA children (study group) and 27 mothers of healthy, none OSA children, with comparable age and gender, (control group) answered the study questionnaire, on behalf of their children, about sleep-time and daytime behavior and symptoms. Results: The mean (±SD) yes answers for the night-time questions for the study group was 6.07 (±2.759), and 0.7 (±0.8) for the control. For the daytime, the mean yes answers was 1.6 (±0.9) for the study and 0.19 (±0.3) for the control group.

Independent samples t-test showed statistically significant differences between the means P=0.000. A statistically significant difference was found between the two groups in the responses for ten of the evaluated night-time symptoms and only one of the daytime symptoms. Conclusions: 1. OSA children had significantly more night and daytime symptoms than the control. 2. Chronic, heavy snoring, difficult breathing during sleep, mouth breathing (during sleep and daytime), and restless sleep were the most commonly reported symptoms.

Key Words: Children, Sleep Apnea, night &daytime behavior and symptoms.

INTRODUCTION

Pediatric sleep-disordered breathing (SDB) represents a spectrum of signs and symptoms, ranging from snoring to upper airway resistance syndrome to obstructive sleep apnea (OSA)[(1)]. Obstructive sleep apnea syndrome (OSAS) is considered the most severe form of SDB, and in children it is defined by the "American Thoracic Society," as a disorder of breathing during sleep characterized by prolonged partial upper airway obstruction and/or intermittent complete obstruction (obstructive apnea) that disrupts normal ventilation and sleep patterns[(2)]. It is usually accompanied by symptoms such as excessive daytime sleepiness, behavioral problems, learning disabilities, growth retardation, or failure to thrive[(3,4)]. SDB is often underdiagnosed in children and teenagers because the primary complaints reported by parents are more often behavioral symptoms[(5)]. The diagnosis of OSAS is usually delayed in children of underdeveloped countries and may take up to three years from the onset of symptoms to diagnosis[(6)].

Delayed diagnosis and treatment of this condition (OSA) is considered as a serious cause of impairment of behavior, school performance as well as metabolic, cardiovascular, and neurocognitive morbidity in children[(7-10)]. Current evidence shows that treatment for OSA in children result in a good outcome with a high 'cure rate' after adenotonsillectomy (AT). Based on a review of 25 published studies evaluating the impact of AT for OSA in children, Garetz (2008) stated that treatments for OSA in children were associated with improvements in one or more measures, including quality of life, behavior, or cognitive function[(11)]. Accordingly, early detection and effective timely referral and management of OSA are highly recommended to help proper child development and to avoid the deleterious consequences of OSA. All health care providers should be aware of the importance of evaluating whether a pediatric patient has, or is at risk of developing, symptoms of sleep-disordered breathing by noting factors associated with it reported by parents or patients and performing a thorough clinical examination[(12)]. Patients should be evaluated both from a dentofacial and medical point of view[(13)].

SDB is of significant relevance to practicing dentists as many studies have reported a positive relationship between craniofacial morphologic characteristics in children and sleep-disordered breathing symptoms. These include long-face syndrome[(7)], high mandibular plane angle[(12,14)], increased overjet, reduced overbite and anterior open bite[(15)], posterior crossbite[(16)], narrow maxilla or deep palatal height[(13-16)] and a tendency for increasing maxillary and mandibular crowding[(14,15)]. Other studies used cephalometric radiographs and found a longer lower facial height in OSA patients compared to control[(17)] and an inferiorly positioned hyoid bone[(18,19)].

The gold standard test for establishing the presence and severity of SBD in children is overnight polysomnography (PSG), however, it is impractical for several reasons, the substantial inconvenience, lack of access, time, and staff costing of PSG recordings may delay routing evaluation[(20,21)].

The inadequate pediatric sleep laboratories to meet the PSG demand and the cost of the exam encouraged the development and the use of other diagnostic and screening methods[22]. Dentists' understanding regarding available appropriate screening methods for SDB should be increased. When a pediatric dental patient is identified as being highly likely to have the disease, dentist should make a proper referral to a pediatric sleep medicine specialist for final diagnosis and treatment[23]. One of the most efficient screening methods for obstructive sleep apnea in a dental setting is a questionnaire about sleep-related symptoms[24]. When the questionnaire was associated with a physical examination, the performance of the screening method improved[23]. A higher chance of having OSAS has been associated with snoring, troubled sleep, nocturnal sweating, oral breathing, poor school achievements, and daily sleepiness[4,25]. Therefore the purpose of the present study was to report the most commonly experienced night and daytime behavior and symptoms by a group of Saudi OSA children and compare them with a healthy control.

Methods:

The study protocol and consent form were permitted by the Research and Ethical Committee of Human Studies at King Saud University, College of Dentistry Research Center. The sample consisted of 27 mothers of OSA children (otherwise healthy) who were recruited from Ear Throat and Nose (ENT) Clinic of National Guard Hospital, Riyadh, Saudi Arabia, after being diagnosed by one consultant of SDB and scheduled for surgical intervention. A control group of 27 mothers of healthy, none OSA children, randomly selected from patients attending College of Dentistry, with comparable age and gender answered the same questionnaire.

Mothers in both groups were asked to answer on behalf of their children about sleep-time behavior and symptom (A), and daytime behavior and symptoms (B).

Part of the questionnaire (A2, A5, A6, A8, A17, B1, B2, B3, B4, B6, B7, B10 & B11) was a modified version of the 22-items pediatric sleep questionnaire[4]. Other questions were formulated from the symptoms that have been reported to be related to SDB and are successively controlled after the appropriate treatment of the breathing disorder has been initiated. These symptoms were listed by Guilleminault and coworkers (2005) after reviewing evidence-based knowledge of pediatric obstructive sleep apnea syndrome[26]. The questionnaire was translated into Arabic, and the Arabic language was checked by three experts' native Arabic speakers. For questionnaire validity; it was pre-tested in 20 mothers, not from the study sample; and changes were made to improve its comprehensibility. The questionnaire was then repeated after four weeks for the same mothers to test the reliability or internal consistency of the questionnaire. All submitted questionnaire remained completely anonymous, and no personal information that might identify the participants or their children were included.

Questionnaire:

Does your child have any of the following?

A. NIGHTTIME SYMPTOMS

1. Abnormal sleeping positions
2. Chronic, heavy snoring
3. Confused arousal
4. Delayed sleep onset
5. Difficult breathing during sleep
6. Difficulty waking up in the morning
7. Drooling
8. Nocturnal enuresis
9. Frequent awakenings
10. Insomnia
11. Mouth breathing
12. Nocturnal migraine
13. Nocturnal sweating
14. Restless sleep
15. Sleep talking
16. Sleepwalking
17. Observed apnea

B. DAYTIME SYMPTOMS

1. Mouth breathing
2. Morning headache
3. Excessive sleepiness
4. Dry mouth on awakening
5. Abnormal shyness, withdrawn and depressive presentation
6. Interrupts or intrudes on others
7. Does not seem to listen when spoken to directly
8. Aggressiveness
9. Irritability
10. Easily distracted by extraneous stimuli
11. Difficulty organizing task and activities
12. Memory impairment

Collected data were analyzed using Statistical Package for Social Sciences "SPSS" Version #20 (Chicago, IL, USA). Descriptive statistics, means and standard deviations, as well as frequencies, were calculated. Independent t-test, Pearson Chi-square, and Fisher's exact tests were used to determine any significant difference ($P \leq 0.05$) in responses according to the nature of the variables studied. For the power of study sample: with alpha=0.05 and the estimated proportional (saying yes) = 0.5(50%) with the power 0.91(91%), the sample size for each group should be at least 26.

Results:

The sex distribution of the study group was 44.4% female and 55.6% male, while for the control group the distribution was 29.6% and 70.4% respectively. Age range was 3-8 years, with a mean age of 5.34 for the study group and 5.86 for the control.

No significant differences in age (t-test P=0.283) or gender (chi-square P=0.260) existed between groups.

A statistically significant difference was found between the study and the control group in the responses for ten of the

evaluated night-time symptoms (Qs: A1, 2, 5, 7, 9, 10, 11, 13, 14 & 17) [Table1], and only one of the daytime symptoms (Q: B1) [Table2]. For questions A2, 5, 11, 14 and B1, positive responses were obtained in most of the study group participants (63.0% - 92.6%) while for questions A1, 9, 13 and 17 positive answers were achieved in 40.7% - 48.1% of the participants. For the control group, the range was from 0.0 % - 7.4% for these questions.

The mean (±SD) of yes answers for the night-time questions for the study group was 6.07 (±2.759), and 0.7 (±0.8) for the control. Independent samples t-test revealed a statistically significant difference between the two means (P=0.000). For the daytime questions, the mean yes answers was 1.6 (±0.9) for the study and 0.19 (±0.3) for the control group with a statistically significant difference between them (P=0.000).

Independent samples t-test showed no statistically significant difference between yes answers for nighttime symptoms of males (5.87±2.416) and females (6.33±3.229) for the study group (P=0.671) and the control group (0.74±0.806, 0.63±1.061, P=0.767). Also for the daytime symptoms no statistically significant difference between males and females for the study P=0.797 and the control group P=0.591.

Using the Pearson correlation; in the study group, age has no correlation with the yes answers for the nighttime symptoms r=0.093 with P=0.644, while for the daytime symptoms yes answers there was a negative correlation with age. As the age increases the daytime symptoms yes answers decrease with a correlation coefficient = -0.39 (39%) and P=0.044. For the control group, age has no correlation with the yes answers during both night and daytime with a correlation coefficient = 0.22 (22%) for the night and 0.31 (31%) for the day and P=0.281 and 0.115 respectively.

For the study group, a positive correlation was found between the yes answers at night with the yes answers during the day using Pearson correlation r=+0.6 (60%) with high significance P=0.001. The likelihood of having day symptoms when having yes answers for each of the evaluated night symptoms is presented in Table 3. The only day symptom that showed considerable yes answers (>7) with night time yes answers was mouth breathing during the day. Mouth breathing during the day was found in all (100%) of the children who had abnormal sleeping positions, frequent awakenings, nocturnal sweating, restless sleep and observed apnea. For other symptoms, the likelihood ranged from 88.9% to 95.7% (Table3). In this table, observations of ≤ seven were not considered important as nonparametric statistics work well with observations of > seven, and those observations could have more effect if the sample size was larger. The numbers of yes answers agreement between each two-night symptoms are presented in Table 4, while Tables 5 & 6 present the conditional probability of one-night symptom given the other.

Discussion:

In the present study the most commonly reported symptoms (63.0% -92.6%) in the OSA children were chronic, heavy snoring, difficult breathing during sleep, mouth breathing (during sleep and daytime), and restless sleep. These symptoms were suggested by the American Academy of Pediatrics (AAP) to be included in the screening of OSA children[27]. According to the literature, OSA should be suspected when nocturnal symptoms of snoring, increased work of breathing, mouth breathing, restless sleep[10,25,28], witnessed apneas[10,28] or nocturnal sweating[25] are reported. Most of these symptoms were reported most in the OSA group of the present study. Chronic, heavy snoring and mouth breathing were the most reported symptoms (85.2%) followed by difficult breathing during sleep (74.1%) and restless sleep (63.0%). Observed apnea was reported in 44.4% of the OSA children, while nocturnal sweating was reported in 40.7%. Also, all of these symptoms were reported significantly more in the OSA children than the control (P≤0.004) (Table 1).

Table 1: Responses of the two groups for nighttime questions.

Nighttime Questions	Groups				P-value**
	Study		Control		
	Yes (%)	No (%)	Yes (%)	No (%)	
A1	13 (48.1)	14 (51.9)	0 (0)	27 (100)	0.000*
A2	23 (85.2)	4 (14.8)	2 (7.4)	25 (92.6)	0.000*
A3	0 (0)	27 (100)	1 (3.7)	26 (96.3)	1.000
A4	4 (14.8)	23 (85.2)	2 (7.4)	25 (92.6)	0.669
A5	20 (74.1)	7 (25.9)	0 (0)	27(100)	0.000*
A6	6 (22.2)	21 (77.8)	4 (14.8)	23 (85.2)	0.484
A7	9 (33.3)	18 (66.7)	1 (3.7)	26 (96.3)	0.005*
A8	0 (0)	27 (100)	2 (7.4)	25 (92.6)	0.491
A9	13 (48.1)	14 (51.9)	0 (0)	27 (100)	0.000*
A10	7 (25.9)	20 (74.1)	0 (0)	27 (100)	0.010*
A11	23 (85.2)	4 (14.8)	2 (7.4)	25 (92.6)	0.000*
A12	1 (3.7)	26 (96.3)	0(0)	27 (100)	1.000
A13	11 (40.7)	16 (59.3)	2 (7.4)	25 (92.6)	0.004*
A14	17 (63.0)	10 (37.0)	0 (0)	27 (100)	0.000*
A15	5 (18.5)	22 (81.5)	2 (7.4)	25 (92.6)	0.420
A16	0 (0)	27 (100)	1 (3.7)	26 (96.3)	1.000
A17	12 (44.4)	15 (55.6)	0 (0)	27 (100)	0.000*

*=sig. difference

**= Pearson Chi-square and Fisher's exact tests were used to compare responses for each question depending on the validity of the Chi-square test

Table 2: Responses of the two groups for daytime questions

Daytime Questions	Groups				P-value**
	Study		Control		
	Yes (%)	No (%)	Yes (%)	No (%)	
B1	25 (92.6)	2 (7.4)	1 (3.7)	26 (96.3)	0.000*
B2	2 (7.4)	25 (92.6)	1 (3.7)	26 (96.3)	1.000
B3	2 (7.4)	25 (92.6)	0 (0)	27 (100)	0.491
B4	5 (18.5)	22 (81.5)	0 (0)	27 (100)	0.051
B5	3 (11.1)	24 (88.9)	1 (3.7)	26 (96.3)	0.610
B6	0 (0)	27 (100)	0 (0)	27 (100)	No difference
B7	1 (3.7)	26 (96.3)	0 (0)	27 (100)	1.000
B8	2 (7.4)	25 (92.6)	1 (3.7)	26 (96.3)	1.000
B9	1 (3.7)	26 (96.3)	1 (3.7)	26 (96.3)	1.000
B10	0 (0)	27 (100)	0 (0)	27 (100)	No difference
B11	1 (3.7)	26 (96.3)	0 (0)	27 (100)	1.000
B12	0 (0)	27 (100)	0 (0)	27 (100)	No difference

*=sig. difference

**= Pearson Chi-square and Fisher's exact tests were used to compare responses for each question depending on the validity of the Chi-square test

Table 3: The likelihood of having yes answer for day time symptoms when having yes answer for night time symptoms for each question

		Day Symptoms									Total Night Yes
		B1	B2	B3	B4	B5	B7	B8	B9	B11	
Night Symptoms	A1	13 (100)	2 (15.4)	1 (7.7)	4 (30.8)	2 (15.4)	0 (0)	1 (7.7)	0 (0)	1 (7.7)	13
	A2	22 (95.7)	2 (8.7)	2 (8.7)	5 (21.7)	3 (13)	1 (4.3)	1 (4.3)	1 (4.3)	1 (4.3)	23
	A4	4 (100)*	1 (25)	1 (25)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4
	A5	19 (95)	2 (10)	2 (10)	5 (25)	3 (15)	1 (5)	1 (5)	1 (5)	1 (5)	20
	A6	6 (100)*	1 (16.7)	1 (16.7)	3 (50)	1 (16.7)	0 (0)	0 (0)	0 (0)	0 (0)	6
	A7	8 (88.9)	1 (11.1)	2 (22.2)	2 (22.2)	1 (11.1)	0 (0)	0 (0)	1 (11.1)	1 (11.1)	9
	A9	13 (100)	2 (15.4)	2 (15.4)	5 (38.5)	3 (23.1)	0 (0)	1 (7.7)	0 (0)	0 (0)	13
	A10	7 (100)*	2 (28.6)	2 (28.6)	3 (42.9)	2 (28.6)	0 (0)	1 (14.3)	0 (0)	0 (0)	7
	A11	21 (91.3)	2 (8.7)	2 (8.7)	5 (21.7)	3 (13)	1 (4.3)	1 (4.3)	1 (4.3)	1 (4.3)	23
	A12	1 (100)*	1 (100)	0 (0)	1 (100)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	1
	A13	11 (100)	1 (9.1)	0 (0)	3 (27.3)	2 (18.2)	1 (9.1)	1 (9.1)	0 (0)	1 (9.1)	11
	A14	17 (100)	2 (11.8)	2 (11.8)	5 (29.4)	3 (17.6)	0 (0)	0 (0)	0 (0)	0 (0)	17
	A15	5 (100)*	1 (20)	1 (20)	2 (40)	0 (0)	0 (0)	1 (20)	0 (0)	0 (0)	5
	A17	12 (100)	2 (16.7)	2 (16.7)	2 (16.7)	2 (16.7)	0 (0)	1 (8.3)	0 (0)	1 (8.3)	12
Total Day Yes		25	2	2	5	3	1	2	1	1	

*Answers ≤ 7.
Questions with 0 responses (A3, 8 & 16 and B6, 10 & 12) were not included in the table.

Table 4: Number of Yes answers agreement between each two night symptoms

Night Symptoms	A2	A4	A5	A6	A7	A9	A10	A11	A12	A13	A14	A15	A17	Row's Yes
A1	11	2	10	5	3	8	6	11	1	7	9	4	8	13
A2		3	18	6	8	12	5	22	1	10	16	5	12	23
A4			4	2	2	3	2	3	0	3	4	1	2	4
A5				6	8	10	6	17	1	10	13	3	8	20
A6					3	4	2	6	0	5	5	3	4	6
A7						4	2	8	0	3	5	2	5	9
A9							6	12	1	5	11	2	6	13
A10								5	1	3	6	2	4	7
A11									1	10	16	5	12	23
A12										1	1	0	1	1
A13											7	3	6	11
A14												3	9	17
A15													4	5
Column's Yes	**23**	**4**	**20**	**6**	**9**	**13**	**7**	**23**	**1**	**11**	**17**	**5**	**12**	

Questions with 0 responses (A3, 8 & 16) were not included in the table

Table 5: The probability of one night symptom given the other (column given row)

Column given Row P (A2/ A1)

Night Symptoms	A2	A4	A5	A6	A7	A9	A10	A11	A12	A13	A14	A15	A17	Row's Yes
A1	0.85*	0.15	0.77*	0.38	0.23	0.62	0.46	0.85*	0.08	0.54	0.69	0.31	0.62	13
A2		0.13	0.78*	0.26	0.35	0.52	0.22	0.96*	0.04	0.43	0.70*	0.22	0.52	23
A4			1.00*	0.50	0.50	0.75*	0.50	0.75*	0.00	0.75*	1.00*	0.25	0.50	4
A5				0.30	0.40	0.50	0.30	0.85*	0.05	0.50	0.65	0.15	0.40	20
A6					0.50	0.67	0.33	1.00*	0.00	0.83*	0.83*	0.50	0.67	6
A7						0.44	0.22	0.89*	0.00	0.33	0.56	0.22	0.56	9
A9							0.46	0.92*	0.08	0.38	0.85*	0.15	0.46	13
A10								0.71*	0.14	0.43	0.86*	0.29	0.57	7
A11									0.04	0.43	0.70*	0.22	0.52	23
A12										1.00*	1.00*	0.00	1.00*	1
A13											0.64	0.27	0.55	11
A14												0.18	0.53	17
A15													0.80*	5

*Probability ≥70
Questions with 0 responses (A3, 8 & 16) were not included in the table

Table 6: The probability of one night symptom given the other (row given column)

Row given Column P (A1/ A2)

	A2	A4	A5	A6	A7	A9	A10	A11	A12	A13	A14	A15	A17
A1	0.48	0.50	0.50	0.83*	0.33	0.62	0.86*	0.48	1.00*	0.64	0.53	0.80*	0.67
A2		0.75*	0.90*	1.00*	0.89*	0.92*	0.71*	0.96*	1.00*	0.91*	0.94*	1.00*	1.00*
A4			0.20	0.33	0.22	0.23	0.29	0.13	0.00	0.27	0.24	0.20	0.17
A5				1.00*	0.89*	0.77*	0.86*	0.74*	1.00*	0.91*	0.76*	0.60	0.67
A6					0.33	0.31	0.29	0.26	0.00	0.45	0.29	0.60	0.33
A7						0.31	0.29	0.35	0.00	0.27	0.29	0.40	0.42
A9							0.86*	0.52	1.00*	0.45	0.65	0.40	0.50
A10								0.22	1.00*	0.27	0.35	0.40	0.33
A11									1.00*	0.91*	0.94*	1.00*	1.00*
A12										0.09	0.06	0.00	0.08
A13											0.41	0.60	0.50
A14												0.60	0.75*
A15													0.33
Column's Yes	23	4	20	6	9	13	7	23	1	11	17	5	

* Probability ≥70
Questions with 0 responses (A3, 8 & 16) were not included in the table

According to previous researches, the most common complaints of parents of children with OSAS are snoring, difficulty breathing during sleep[4,29,30] and mouth breathing[4,31]. Although snoring is the most prevalent symptom of pediatric obstructive sleep apnea, history of snoring alone cannot distinguish between children with OSAS and children with primary snoring[32]. However, snoring itself may play an important role in the pathogenesis of associated cognitive and behavioral morbidity and found to be strongly predictive of a future diagnosis of hyperactivity over the long-term [33,34]. Huynh and coworkers (2011) found significant associations between predominant mouth breathing and many pediatric OSA symptoms[12]. Mouth breathing results in Inferoposterior rotation of the mandible changing the position of the genioglossal muscle by decreasing tongue protrusion.

Inferoposterior positioning of the hyoid bone includes narrowing of the posterior airway space and is the cause of respiratory disorder in some children while sleeping[35]. In the present study, mouth breathing was reported in most of the OSA children during sleep (85.2%) and daytime (92.6%) compared to very few only in the control group (7.4% & 3.7% respectively). Therefore, maintaining nasal breathing during childhood is important for preventing changes in the facial skeleton that reduce upper airway stability during sleep.

OSA children tend to be very restless during the night and sleep while hyperextending the neck where the hyoid bone is elevated providing temporary relief of the obstruction[35,36]. In the present study, abnormal head position and restless sleep were reported in a considerable number of OSA children (48.1% & 63.0% respectively) while none of these symptoms were reported in the control group.

According to Muzumdar and Arens (2008), parents of OSA children often describe episodes of retractions and increased respiratory effort. Their explanation for that was "In the presence of complete or partial upper airway obstruction, inspiratory downward motion of the diaphragm will expand the abdominal wall; however, the sudden increase in negative intrathoracic pressure will cause a paradoxical inward movement of the highly compliant ribcage of the young child. These episodes may be terminated by gasping, movement, or frequent awakenings[31]". Arousal is a vital protective mechanism against apnea. Sleep apnea has three main types: central, obstructive or mixed, and children have a higher arousal threshold than adults[37].

The younger the child, the more the arousal threshold[38]. Witnessed apnea in children with OSA was significantly less common than in adults with OSA[28]. In the present study observed apnea and frequent awakening were reported in OSA children less commonly than snoring, mouth breathing, difficult breathing and restless sleep, but significantly more than the control group (P=0.000). Nocturnal symptoms that were less reported by OSA group, and still showed significant difference than control include nocturnal sweating, drooling, and insomnia. All other nocturnal symptoms evaluated in this study were reported either by few cases of the OSA group (difficulty waking up in the morning, sleep talking, delayed sleep onset and nocturnal migraine) with no significant difference than the control or not reported at all (confused arousal, nocturnal enuresis and sleep walking) in any of the OSA group.

Some researchers suggested the association of OSA and even primary snoring with nocturnal enuresis[39,40], while others reported that nocturnal enuresis was significantly associated with the presence of moderate-to-severe OSA[41]. In the present study nocturnal enuresis was not reported in any of the OSA children, but reported in two cases (7.4%) of the control group. Regarding the daytime symptoms evaluated in this study, a highly significant difference (P=0.000) was found in daytime mouth breathing between OSA group and the control. In the study group a high probability of having day mouth breathing was found when having abnormal sleeping positions, snoring, difficult breathing and mouth breathing during sleep, frequent awakenings, nocturnal sweating, restless sleep and observed apnea. All other daytime symptoms were not significantly different than the control group. In a recent update on pediatric OSA, Dehlink and Tan (2016) reported that daytime symptoms of OSA are very non-specific, but together with nighttime symptoms may help alert clinicians to clinically significant obstructive SDB: hyperactivity, difficulty concentrating/learning difficulties, behavioral problems, excessive daytime sleepiness, and moodiness[10].

According to the literature, and in contrast to reports in adults with OSA, excessive daytime sleepiness is less common in children with OSA, being present in only 7 to 10% of OSA children[28,32,42,43]. Similar findings were observed in the present study as excessive daytime sleepiness was reported only in two (7.4%) of the OSA children. Some researchers referred that to the reduced number of awakenings and relative preservation of sleep architecture in children[22], while others suggested that children with OSAS may have a threshold for sleepiness that differs from that of adults[31]. On the other hand, Chervin and coworkers (2000) reported that daytime sleepiness is an important symptom of sleep-related breathing disorders (SRBDs) in children, as in adults, but also suggest that this symptom may be less prominent than other daytime behaviors among children with SRBDs[4].

Recent studies, meta-analyses, and comprehensive reviews have linked untreated OSAS symptoms in children to both externalizing[44,45] and internalizing[46] behavior problems, as well as neurocognitive, and academic functioning[47,48].

SDB-related behavioral and neurocognitive impairments may vary according to child age, as Jackman and colleagues (2012) reported that children aged 3-5 years with SDB experienced behavioral, but not neurocognitive deficits, while Bourke and coworkers (2011) reported that SDB children aged 7-12 years did show diminished neurocognitive skills[45,48]. These findings highlight the importance of early diagnosis and treatment to prevent subsequent neurocognitive impairments. The effect of age at which OSA develops could also modify

the frequency and severity of the morbid consequences, as well as influence the degree of reversibility after treatment[49]. In the present study, no statistically significant difference was found between the OSA children and the control in the reported behavioral or cognitive symptoms. Similarly O'Brien and coworkers (2004) and Blunden and colleagues (2000) reported no behavioral problems difference between SDB children and control, but conversely, both studies reported that children with SDB showed significant neurocognitive deficits compared with control[50,51]. Marcus and coworkers (2013), in the first randomized controlled trial on pediatric OSAS and adenotonsillectomy reported a normal range of baseline cognitive scores of children with OSA(44), a similar finding to that in the current study. A recent functional MRI-imaging study has reported changes in the cognitive and empathetic processing in children with OSA, compared with children without OSA, even when no differences were observed on standardized neuropsychological testing by experienced child psychologists[52].

Some research findings have been less consistent in reporting associations between OSAS or SDB and internalizing outcomes[47], on the other hand, Yilmaz and colleagues (2013) in a meta-analytic data reported a medium relationship between depressive symptoms and OSA[46], while Lewin and coworkers (2002) found that children with SDB had significantly higher scores than healthy controls for attention problems, anxiety/depression, social problems, and aggressive behaviors based on parents' reports[53]. In the present study depressive presentation was reported in 11.1% of OSA children compared to 3.7% in control (P=0.610).

Some children with severe OSA do not experience neurocognitive or behavioral morbidity, whereas some children with relatively mild OSA do, Dehlink and Tan (2016) referred that to the differential compensatory mechanisms adopted and individual variability in neuroplasticity which are influenced by genetic and environmental factors[10]. While other researcher attributed the variation to the use of report-based (parent questionnaire) versus performance-based (behavioral tasks) measures to assess these skills [47,54]. Brunetti and coworkers (2001) referred the absence of typical daily symptoms to the less sleep disruption they found in OSA children as compared to affected adults[25]. Sans Capdevila and coworkers (2008) in a review of OSA listed multiple genetic and environmental factors that may explain the observation that not all children with OSA manifest cognitive morbidities, these include; increased body mass index (BMI), C-reactive protein levels, the presence of apolipoprotein E, nutrition type, in addition to passive or active exposure to cigarette smoking, recurrent exposure to respiratory viruses, intensity of intellectual activity, and the level of physical activity[49]. They also reported that all these factors can affect both the pathophysiological risk for OSA as well as modify the susceptibility to the consequences of OSA. Similar to previous studies [55,56] the current study showed no statistically significant difference between males and females in OSA symptoms. The ability to uncover behavioral or cognitive differences in the present study may have been affected due to the comparatively small number of subjects studied which is considered one of the limitations of this study in addition to other limitations such as depending solely on mother's responses which depends on memory, not including other factors such as socioeconomic status and body mass index and assuming all control subjects to be free of OSA.

Conclusions:

Within the limitation of this study, we can conclude that:

1. OSA children had significantly more night and daytime symptoms than the control.
2. Chronic, heavy snoring, difficult breathing during sleep, mouth breathing (during sleep and daytime), and restless sleep were the most commonly reported symptoms.
3. Mouth breathing during the day was found in all children who had abnormal sleeping positions, frequent awakenings, nocturnal sweating, restless sleep and observed apnea.

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References:

[1] Goldstin, NA, Stefanov, DG, Graw-Panzer KD, Fahmy, SA, Fishkin, S, Jackson A, et al. Validation of a clinical assessment score for pediatric sleep-disordered breathing. Laryngoscope. 2012;122(9):2096-104.

[2] American Thoracic Society. "Standards and indications for cardiopulmonary sleep studies in children. American Thoracic Society." Am J Resp Crit Care. 1996;153(2):866-78.

[3] Marcus CL, Brooks LJ, Ward SD, Draper KA, Gozal D, Halbower AC, et al. Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome. Pediatrics. 2012;130:714-55.

[4] Chervin R, Hedger K, Dillon J, Pituch K. Pediatric sleep questionnaire (PSQ): validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. Sleep medicine clinics. 2000;1:21-32.

[5] Lopes MC, Guilleminault C. Chronic snoring and sleep in children: a demonstration of sleep disruption. Pediatrics. 2006;118:e741-6.

[6] Bower C, Buckmiller L. What´s new in pediatric obstructive sleep apnea. Current opinion in otolaryngology & head and neck surgery. 2001;9:352-8.

[7] Katz ES, D'Ambrosio C. Pediatric Obstructive Sleep Apnea Syndrome. Clin Chest Med 2010;31(2):221-34.

[8] Demko BG . Screening for obstructive sleep apnea in the dental office setting. J Mass Dent Soc. 2008;57(1):18-20.

[9] Chervin RD, Dillon JE, Bassetti C, Ganoczy DA, Pituch KJ. Symptoms of sleep disorders, inattention, and hyperactivity in children. Sleep. 1997;20:1185-92.

[10] Dehlink E, Tan HL. Update on paediatric obstructive sleep apnoea. Journal of thoracic disease. 2016;8(2):224-35. Epub 2016/02/24.

[11] Garetz SL. Behavior, cognition, and quality of life after adenotonsillectomy for pediatric sleep-disordered breathing: summary of the literature. Otolaryngol Head Neck Surg. 2008;138:19-26.

[12] Huynh NT, Morton PD, Rompre PH, Papadakis A, Remised C. Associations between sleep-disordered breathing symptoms and facial and dental morphometry, assessed with screening examinations. Am J Orthod Dentofacial Orthop 2011. 2011;140:762-70).

[13] `Zettergren-Wijk L. A Longitudinal Study of Dentofacial Morphology in Young Children Treated for the Obstructive Sleep Apnea Syndrome. Stockholm, Sweden: Department of Orthodontics, Institute of Odontology,Karolinska Institute; 2008. Available at: "http://publications.ki.se/xmlui/bitstream/handle/10616/40204/thesis. 2008.

[14] AlHammad NS, Hakeem LA, Salama FS. Orofacial findings associated with obstructive sleep apnea in a group of Saudi Children. Pakistan journal of medical sciences. 2015;31(2):388-92. Epub 2015/06/24.

[15] PiriläParkkinen K, Pirttiniemi P, Nieminen P, Tolonen U, Pelttari U, Löppönen H. Dental arch morphology in children with sleep-disordered breathing. . Eur J Orthod. 2009;31:160-7.

[16] Lofstrand-Tideström B, Thilander B, Rastad A, Jakobsson O, Hultcrantz E. Breathing obstruction in relation to craniofacial and dental arch morphology in 4-year-old children. Euro J Orthodontics. 1999;21:323-32.

[17] Deng J, Gao XF. A case-control study of craniofacial features of children with obstructed sleep apnea. . Sleep Breath. 2012;16:1219-27.

[18] Vieira BB, Itikawa CE, de Almeida LA, Sander HH, Aragon DC, Anselmo-Lima WT, et al. Facial features and hyoid bone position in preschool children with obstructive sleep apnea syndrome. Eur Arch Oto-Rhino-L. 2014;271(5):1305-9.

[19] Johns FR, Strollo PJ Jr, Buckley M, Constantino J. The influence of craniofacial structure on obstructive sleep apnea in young adults. . Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons. 1998;56:596- 603.

[20] Wu Y, Xu Z, Zhang L, Shen K. Screening obstructive sleep apnea-hypopnea syndrome from snorers in children by heart rate variability analysis. Biol Rhythm Res. 2015;46(2):161-71.

[21] Villa MP, Sujanska A, Vitelli O, Evangelisti M, Rabasco J, Pietropaoli N, et al. Use of the sleep clinical record in the follow-up of children with obstructive sleep apnea (OSA) after treatment. Sleep Breath. 2016;20(1):321-9.

[22] Balbani APS, Weber SAT, Montovani JC. Update in Obstructive Sleep Apnea Syndrome in Children. Rev Bras Otorrinolaringol. 2005;71(1):74-80.

[23] Canto G, Singh V, Major M, Witmans M, El-Hakim H, Major P, et al. Diagnostic capability of questionnaires and clinical examinations to assess sleep-disordered breathing in children: a systematic review and meta-analysis. . J Am Dent Assoc. 2014;145:165-78.

[24] Shigemoto S, Shigeta Y , Nejima J, Ogawa T, Matsuka Y, Clark, GT. Diagnosis and treatment for obstructive sleep apnea: Fundamental and clinical knowledge in obstructive sleep apnea. Journal of Prosthodontic Research 2015;59(3):161-71.

[25] Brunetti L, Rana S, Lospalluti ML, Pietrafesa A, Francavilla R, Fanelli M, et al. Prevalence of Obstructive Sleep Apnea Syndrome in a Cohort of 1,207 Children of Southern Italy. Chest. 2001;120: 1930–5.

[26] Guilleminault C, Lee J H, Chan A. Pediatric Obstructive Sleep Apnea Syndrome. Arch Pediatr Adolesc Med 2005;159:775-85.

[27] American Academy of Pediatrics, Section on Pediatric Pulmonology, Subcommittee on Obstructive Sleep Apnea Syndrome. Clinical practice guideline: diagnosis and management of childhood obstructive sleep apnea syndrome. . Pediatrics. 2002;109:704–12.

[28] Choi JH, Kim EJ, Choi J, Kwon SY, Kim TH, Lee SH, et al. Obstructive sleep apnea syndrome: a child is not just a small adult. Ann Otol Rhinol Laryngol 2010;119(10):656-61.

[29] Guilleminault C, Korobkin R, Winkle R. A review of 50 children with obstructive sleep apnea syndrome. . Lung. 1981;159:275–87.

[30] Brouilette R, Hanson D, David R, Klemka L, Szatkowski A, Fernbach S, et al. A diagnostic approach to suspected obstructive sleep apnea in children. J Pediatr Urol. 1984;105:10–4

[31] Muzumdar H, Arens R. Diagnostic Issues in Pediatric Obstructive Sleep Apnea Proc Am Thorac Soc 2008;5:263-73.

[32] Carroll JL, McColley SA, Marcus CL, Curtis S, Loughlin GM. Inability of clinical history to distinguish primary snoring from obstructive sleep apnea syndrome in children. Chest. 1995;108:610–8.

[33] Chervin RD, Weatherly RA, Garetz SL, Ruzicka DL, Giordani BJ, Hodges EK, et al. Pediatric sleep questionnaire: Prediction of sleep apnea and outcomes. Arch Otolaryngol. 2007;133(3):216-22.

[34] Chervin RD, Ruzicka DL, Archbold KH, Dillon JE. Snoring predicts hyperactivity four years later. Sleep Biol Rhythms. 2005;28(7):885-90.

[35] Finkelstein Y, Wexler D, Berger G, Nachmany A, Shapiro-Feinberg M, Ophir D. Anatomical basis of sleep-disordered breathing abnormalities in children with nasal obstruction. Arch Otolaryngol Head Neck Surg. 2000; 126:593-600.

[36] Stradling JR, Thomas G, Warley AR, Williams P, Freeland A. Effect of adenotonsillectomy on nocturnal hypoxaemia, sleep disturbance, and symptoms in snoring children. . Lancet Neurol. 1990;335:249-53.

[37] Alsubie HS, BaHammam, AS. Obstructive Sleep Apnoea: Children are not little Adults. Paediatr Respir Rev. 2016. Epub 2016/06/06.

[38] Parslow PM, Harding R, Cranage SM, Adamson TM, Horne RSC. Arousal responses to somatosensory and mild hypoxic stimuli are depressed during quiet sleep in healthy term infants. Sleep. 2003;26(6):739–44.

[39] Brooks LJ, Topol HI. Enuresis in children with sleep apnoea. J Pediatrics. 2003;142:515–8.

[40] Barone JG Hanson C, DaJusta DG, Gioia K, Englan J, Schneider D. Nocturnal enuresis and overweight are associated with obstructive sleep apnea. Pediat-rics. 2009;124(1):e53–9.

[41] Alexopoulos EI, Malakasioti G, Varlami V, Miligkos M, Gourgoulianis K, Kaditis AG. Nocturnal enuresis is associated with moderate-to-severe obstructive sleep apnea in children with snoring. Pediatr Res. 2014;76(6):555-9.

[42] Rosen C. Clinical features of obstructive sleep apnea hypoventilation syndrome in otherwise healthy children. . Pediatric pulmonology. 1999;27:403–9.

[43] Gozal D, Wang M, DW P. Objective sleepiness measures in pediatric obstructive sleep apnea. Pediatrics. 2001;108:693–7.

[44] Marcus CL, Moore RH, Rosen CL, Giordani B, Garetz SL, Taylor HG e. A Randomized Trial of Adenotonsillectomy for Childhood Sleep Apnea. N EnglJMed. 2013;368(25):2366-76.

[45] Jackman AR, Biggs SN, Walter LM, Embuldeniya US, Davey MJ, Nixon GM, et al. Sleep-disordered breathing in preschool children is associated with behavioral, but not cognitive, impairments. Sleep Med. 2012;13:621–31.

[46] Yilmaz E, Sedky K, Bennett D. The relationship between depressive symptoms and obstructive sleep apnea in pediatric populations: a meta-analysis. J Clin Sleep Med. 2013;9(11):1213–20.

[47] Beebe D. Neurobehavioral morbidity associated with disordered breathing during sleep in children: a comprehensive review. 2006; . Sleep. 2006;29(9):1115–34.

[48] Bourke R, Anderson V, Yang JSC, Jackman AR, Killedar A, Nixon GM, et al. Cognitive and academic functions are impaired in children with all severities of sleep-disordered breathing. Sleep medicine. 2011;12(5):489-96.

[49] Sans Capdevila O, Kheirandish-Gozal L, Dayyat E, Gozal D. Pediatric Obstructive Sleep Apnea:Complications, Management, and Long-term Outcomes. Proc Am Thorac Soc 2008;5:274–82.

[50] O'Brien LM, Mervis CB, Holbrook CR, Bruner JL, Smith NH, McNally N, et al. Neurobehavioral correlates of sleep-disordered breathing in children. J Sleep Res. 2004;13(2):165-72. Epub 2004/06/04.

[51] Blunden S, Lushington K, Kennedy D, Martin J, Dawson D. Behavior and neurocognitive performance in children aged 5-10 years who snore compared to controls. Journal of clinical and experimental neuropsychology. 2000;22(5):554-68. Epub 2000/11/30.

[52] Kheirandish-Gozal L, Yoder K, Kulkarni R, Gozal D, Decety J. Preliminary functional MRI neural correlates of executive functioning and empathy in children with obstructive sleep apnea. Sleep. 2014;37(3):587-92. Epub 2014/03/04.

[53] Lewin DS, Rosen RC, England SJ, Dahl RE. Preliminary evidence of behavioral and cognitive sequelae of obstructive sleep apnea in children. Sleep medicine. 2002;3(1):5-13. Epub 2003/11/01.

[54] Blechner M, Williamson AA. Consequences of Obstructive Sleep Apnea in Children. Current problems in pediatric and adolescent health care. 2016;46(1):19-26. Epub 2015/12/04.

[55] Redline S, Tishler PV, Schluchter M, Aylor J, Clark K, G. G. Risk factors for sleep-disordered breathing in children. Associations with obesity, race, and respiratory problems. . Am J Respir Crit Care Med. 1999;159:1527–32.

[56] Tamanyan K, Walter L M, Davey M J, Nixon G M, Horne R S, Biggs S N. Risk factors for obstructive sleep apnoea in Australian children. J Paediatr Child Health. 2016;52(5):512-7