

## The Relationship between Sleep Disordered Breathing and Obesity in a Tertiary Care Centre, Saudi Arabia

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### Abstract

**Background:** Sleep disordered breathing (SDB) is aggravated by overweight and obesity particularly among children. The present study aimed to assess SDB in Saudi obese children.

**Methods:** A retrospective study performed in the Pediatric Sleep Disorders Centre (PSDC) which is a tertiary referral medical center at Prince Sultan Military Medical City (PSMMC), Riyadh. Forty eight children (mean age  $10.3 \pm 2.3$  years, range 7-18 years) participated in this study. The cases were referred to PSDC by Pediatricians and physicians of primary care centers of different specialties from hospitals all over Saudi Arabia to PSDC.

**Results:** The mean ( $\pm$  SD) apnea hypopnea index (AHI) for the participants was ( $6.39 \pm 13.28$ ). The AHI in the male subjects ( $8.15 \pm 16.55$ ) was higher than the females ( $4.57 \pm 8.67$ ) but not statistically significant. Overall, hypopnea is the most common SDB among obese children 14 (27.5%) followed by obstructive sleep apnea (OSA) in 13 subjects (25.5%) and both were encountered in 7 children (13.7%). Among males, OSA was the most common disease while in females; hypopnea was the most common disease. Forty three (84%) of the children reported habitual snoring with no statistical significant difference between male 23 (88%) and females 20 (80%).

**Conclusion:** Obesity could be a risk contributor for SDB among Saudi children. The most common type of SDB associated with obesity was hypopnea followed by OSA. The results of the current study might suggest the need for further wider studies to study the role of SDB among Saudi children in overweight and obesity.

**Keywords:** Obesity; Sleep Disordered Breathing; Obstructive Sleep Apnea Syndrome; Children

### Introduction

Obesity is considered a major universal community health problem and could lead to a group of chronic diseases, such as diabetes mellitus, coronary artery diseases and malignancy. Over the past three decades, the frequency of obesity has been doubled globally [1]. The prevalence rate of obesity in Saudi Arabia is one of the highest in the region. This might be due to the westernization of the Saudi lifestyle in food habits over the past few decades [2]. De Nicola, *et al.* [3] reported that the problem of obesity in Saudi Arabia is a major health problem, where 7 out of 10 people are considered obese.

Not only among adults, but also among young age children and adolescents the incidence of obesity is also increasing all over the world and becomes an epidemic in some countries. There is considerable data for the existence of globally rise of childhood obesity [4,5]. Obesity health problem is affecting both developed countries and developing ones including Saudi Arabia [6].

The Kingdom of Saudi Arabia (KSA) realized the increasing incidence of obesity and overweight among young Saudi children and adolescents and started to plan controlling the problem [7]. Al-Shehri, *et al.* [8] indicated that obesity is affecting both genders Saudi males and females and they raised the need for efficient Governmental plans to manage the obesity among Saudi children. The studies about obesity in Saudi Arabia indicated that obesity is a major cause for many other health problems and diseases, including elevated blood pressure, diabetes mellitus, dyslipidemias, obstructive sleep apnea and arthritis [1,9].

Sleep duration and quality is affected by sleep disorders (SD) and this has been associated with increases in the prevalence rate of increased body mass index and adiposity [10]. This observation directed the clinical researches to link between sleep disordered problems and other chronic disease [11]. Knowing more about this link would help in finding more effective management for obesity and also SD [12].

In the study of Al-Hazaa, *et al.* [13] covering 3 major cities in KSA, they illustrated that the occurrence of short sleep duration among Saudi adolescents was considerably associated with high prevalence of obesity.

Clinical research studies demonstrated a significant association between occurrence of obstructive sleep apnea (OSA) and presence of obesity. About 75% of persons with OSA were found to be obese with body mass index above 30 [14,15]. It is indicated that the severity of OSA is highly increased by obesity may be due to pressure on the upper airway passages, abnormal control of the respiratory neuromuscular autonomic regulation, or overproduction of adipokine hormone [16].

### Aim of the Work

The present study aimed to evaluate the incidence of SDB in Saudi obese children in a sleep centre from a tertiary referral health center from all over Saudi Arabia. Moreover, the significance of their disease was assessed by measuring the apnea-hypopnea index (AHI).

### Materials and Methods

#### Study design

The design of this study was a retrospective study performed in the Pediatric Sleep Disorders Center (PSDC) which is a tertiary referral medical centre at Prince Sultan Military Medical City (PSMMC), Riyadh, KSA.

#### Study subjects

- The participants of the study were recruited from PSDC at PSMMC, which is considered a tertiary referral medical center in Riyadh, KSA.
- Forty eight children (mean age 10.3 ( $\pm$  2.3) years, range 7 - 18 years) participated in this study. The cases were referred to PSDC by Pediatricians and physicians of primary care centers of different specialties from hospitals all over KSA to PSDC. Every child had a thorough history and physical examination. The exclusion criteria included: Children with Down's syndrome, Prader-Willi syndrome, laryngomalacia, neuromuscular diseases, or any other genetic disease or craniofacial abnormality or surgery in the upper respiratory tract.

- In addition, parents signed a formal consent after explanation of the aim of the study. The parents and whenever possible the children then completed a subjective pediatric sleep questionnaire to assess excessive daytime sleepiness (EDS). All participants answered the questionnaire and all of them underwent polysomnography (PSG) at least 6-h polysomnographic study.
- The child was considered obese if his/her definite weight > 120% of the ideal weight for height (IBW). Obstructive apnea index > or = 1 or obstructive apnea-hypopnea index (OAHI) > or = 2, further classified as mild (2 < or = OAHI < 5) or moderate-to-severe (OAHI > or = 5), were used as diagnostic criteria for OSAS.
- The diagnosis of primary snoring was through using a microphone to detect snoring and calculating normal obstructive indices and saturation.
- A questionnaire with 22 questions was filled by the parents if more than 5 years.
- The PSMC ethics committee approved the study. The current study was explained to the parents and assured that all their information will not be revealed and maintained confidentiality to all except for the publication. A written informed consent was obtained from the participants or their parents after explaining the aim of the study.

### Polysomnography (PSG) study

The PSG study was performed using a device with multiple leads that were connected to the subject in specific sitting in the sleep lab by an expert technician that knows the place of each leads and how to interpret the result. The following measures were recorded: 1. The electro-oculogram of both eyes, 2. The electroencephalogram, 3. The submental electromyogram of abdomen, intercostals, and leg muscles, 3. The electrocardiogram, 4. The end tidal CO<sub>2</sub> and arterial O<sub>2</sub> saturation, 5. snoring through a microphone to hear and record the snoring sounds.

The obtained data were subjected for more examination and final review by a sleep physician consultant.

### Statistical analysis

The obtained results were illustrated as mean ± standard deviation (SD). The statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 24. The X<sup>2</sup> test, independent t test and whenever needed stepwise logistic regression was performed. For the analyses, p value less than 0.05 was considered to be statistically significant.

### Results

The subjects included in the study was 51, 26 (51%) males and 25 (49%) females. The body mass index (BMI) in the female subjects (35.04 ± 7.78) was slightly higher than the males (34.51 ± 7.01) but not statistically significant. Seven males and 3 females were overweight (BMI ≥ 25 and < 30), while 18 males and 19 females were obese (BMI ≥ 30). The mean (± SD) OAHI for the participants was (6.39 ± 13.28). The AHI in the male subjects (8.15 ± 16.55) was higher than the females (4.57 ± 8.67) but not statistically significant (Table 1).

	Total	Males	Females	P value
N (%)	51 (100%)	26 (51%)	25 (49%)	NS
Age (years)	8.94 ± 3.10	8.69 ± 3.43	9.20 ± 2.77	NS
Weight (kg)	70.12 ± 29.00	72.39 ± 32.68	67.76 ± 25.06	NS
Height (m <sup>2</sup> )	138.60 ± 18.79	140.85 ± 21.00	136.26 ± 16.29	NS
BMI (Kg/m <sup>2</sup> )	34.77 ± 7.33	34.51 ± 7.01	35.04 ± 7.78	NS
OAHI	6.39 ± 13.28	8.15 ± 6.55	4.57 ± 3.67	NS

**Table 1:** The demographic data for the participants.

The results are mean ± standard deviation (SD). BMI, body mass index = body weight/body height 2.

OAHI, obstructive apnea-hypopnea index. NS: Non Significant p > 0.05.

Overall, Hypopnea is the most common SDB among obese children 14 (27.5%) followed by OSAS in 13 subjects (25.5%), and both were encountered in 7 children (13.7%). Among males, OSAS was the most common disease while in females; hypopnea was the most common disease (Table 2).

	Overall	Males	Females
Hypopnea	14 (27.5%)	6 (23%)	8 (32%)
OSAS	13 (25.5%)	8 (31%)	5 (20%)
OSAS/Hypopnea	7 (13.7%)	5 (19%)	2 (8%)

**Table 2:** The common type of sleep disordered breathing in the obese children.  
OSAS: Obstructive Sleep Apnea Syndrome.

Concerning habitual snoring among participant, 84% of the them reported to have it for four nights or more per week during the last year with no statistical significant difference ( $p>0.05$ ) between male 23 (88%) and females 20 (80%) (Table 3).

	Overall	Males	Females
+	43 (84%)	23 (88%)	20 (80%)
-	8 (16%)	3 (12%)	5 (20%)

**Table 3:** Habitual snoring in the studied children.

The type of PSG study that has been used for each patient depending on his/her clinical scenario is shown in table 4. Full PSG means: the study was done for 6 hours whole; split-night means: half of the night was diagnostic and half was with intervention; titration: putting the patient of non-invasive ventilation and adjust the oxygenation (increase accordingly); re-titration: patient need further adjustment.

	Overall		Males		Females	
Full PSG	42	(82%)	20	(77%)	22	(88%)
Full PSG/Split-night	1	(2%)	0	(0%)	1	(4%)
Full PSG/Titration/Desensitization	1	(2%)	1	(4%)	0	(0%)
Re-titration	1	(2%)	0	(0%)	1	(4%)
Split-night	1	(2%)	1	(4%)	0	(0%)
Standard PSG	3	(6%)	2	(8%)	1	(4%)
Titration	1	(2%)	1	(4%)	0	(0%)

**Table 4:** Polysomnography (PSG) study in the obese children.

The male children with higher BMI are more susceptible to SDB than females. However, no statistically significant correlation was demonstrated between values of the BMI and the degree of severity of SDB in our candidates (Table 5).

Correlation			
	All	Males	Females
BMI and SDB	0.36	0.44	0.28
BMI and PSG	0.069	0.137	0.003
BMI and Number of studies	0.22	0.17	0.27
BMI and AHI	0.133	0.275	-0.076
BMI and snoring	0.004	0.074	-0.041

**Table 5:** The overall correlation between the BMI and SDB.

The data gained from the stepwise logistic regression analysis of the results showed no statistical significant correlation between values of BMI and any associate medical condition of patients (Table 6). The stepwise logistic regression analysis shows that there is no significant relation between BMI and gender of patients. Thus, we can conclude that there is no relationship between BMI and gender (Table 7).

	Estimate	Standard Error	t-value	p-value
Asthma	-2.50	4.07	-0.62	0.54
Asthma + Apnea	-7.00	7.80	-0.897	0.38
Asthma + Narcolepsy	-1.90	7.80	-0.24	0.81
Asthma + Renal Disease	-9.00	7.80	-1.15	0.26
Autism	-0.65	5.60	-0.12	0.91
Brandt Biedl Syndrome	-1.20	7.80	-0.15	0.88
Asthma + Chronic Lung Disease + PHT	-4.60	7.80	-0.59	0.56
Chronic Disease	-10.70	7.80	-1.37	0.18
DM	2.70	7.80	0.35	0.73
HTN	4.60	7.80	0.59	0.56
OSA	12.60	7.80	1.62	0.12
ROHHAD	-0.80	7.80	-0.10	0.92
Sacral Anagenesis	4.60	7.80	0.59	0.56

**Table 6:** Stepwise logistic regression analysis between BMI and associate medical condition.

Regression: Relationship between BMI and Gender				
	Estimate	Standard Error	t-value	p-value
Intercept	35.04	1.48	23.68	<0.0001**
Gender	-0.52	2.07	-0.25	0.80

**Table 7:** Stepwise logistic regression analysis between BMI and gender.

## Discussion

The prevalence of SDB in childhood was reported to be more frequent among overweight and obese ones than children with normal weight and BMI. It is well known that SDB is associated with considerable dysfunction of many viable organs and systems in the body, particularly cardiovascular and metabolic complications [17]. It is crucial to recognize the causes, factors, and effects of SDB particularly in obese children. Moreover, the diagnosis and treatment of SDB would help the health system to prevent or decrease the morbidity linked with SDB [18].

Normal sleep pattern is essential for children to be healthy. SDB is disruption of the normal ventilation and normal respiratory patterns during sleep and if occurred in children accompanied by many health problems both physically and behaviorally. One of the most common SDB in children is OSAS that can result in considerable morbidity such as metabolic disorders, disturbance in development, and even cardiovascular disease [19].

In spite being a complex investigation, the sleep study polysomnography (PSG) is currently the superior standard for a precise diagnosis of OSAS [20]. In the present study PSG was used to determine SDB and measure the OAHl. The results of the present study illustrated that the most common type of SDB in the clinical sample of Saudi obese children referred to our sleep center (PSDC at PSMMC, Riyadh, KSA), was hypopnea and OSAS. Overall, hypopnea is the most common SDB among the participants (27.5%) followed by OSAS (25.5%) and both were encountered in 13.7% of the Saudi obese children. Among males, OSAS was the most common disease while in females; hypopnea was the most common SDB condition.

The results of the present work was parallel to earlier studies in developed countries that reported more than 30% of their obese children suffering from considerable SDB with OSAS the most common type [21-23]. Moreover, Peppard, *et al.* [24] and Meltzer, *et al.* [25] demonstrated that the incidence of hypopnea and OSAS is steadily increasing among children with obesity or overweight.

There could be many predisposing factors to explain the pathophysiology of sleep disordered breathing among children suffering from obesity. These factors could include certain genetic factors with certain upper airway narrowing or problems in the central neuromotor and ventilatory control in obese children [26]. Therefore, obesity could predispose to SDB in children through pressure of the fat mass over the upper respiratory airways and/ or the respiratory muscles in addition to certain impairment in ventilatory control [27,28].

This result is in accordance with the results of Wing, *et al.* [29] who reported increased risk of obstructive SDB among obese children when compared to normal weight children. They suggested aggressive treatment and management of any enlargement of the pharyngeal lymphoid tissue in obese children to reduce the risk of SDB. Moreover, the results of Wing and his colleagues [29] showed that neither the gender of the child nor the age was important risk factors for occurrence of SDB which is in accordance with the present results.

In the study of Wing, *et al.* [29] they indicated that male obese children were more susceptible for suffering from SDB compared to the females. The authors explained that the obese male children in their study were much heavier than the females. In agreement with this finding, the results of the present work demonstrated that OAHl in the male subjects was higher than the females but not statistically significant.

Furthermore, the study of Carriere, *et al.* [18] verified that the sleep disorders in the majority (98.4%) of the examined obese children was of respiratory sleep disorders type. The polysomnography study performed to those obese children confirmed that about half of them had respiratory sleep disorders with OSAS is the commonest type.

Kalra, *et al.* [19] stated that the occurrence of OSAS in children suffering from obesity can be as high as more than 50%. In addition, Marcus, *et al.* [30] work reported that about half of the studied obese children by polysomnography had OSAS. Similarly, Silvestri, *et al.* [31] indicated that OSAS was diagnosed among more than half of obese children that were evaluated for manifestations of SDB.

The stepwise logistic regression analysis of the present findings showed that there was no significant relation between BMI and OSAS in Saudi obese children. However, Mallory, *et al.* [22] indicated that the degree of obesity correlates with the severity of OSAS in obese children. Moreover, Redline, *et al.* [32] illustrated that increased BMI is a major risk factor for the presence and severity of OSAS.

The characteristic symptoms of OSAS include habitual snoring and noticed sleep apneas, but actually not all persons with snoring complained from typical OSAS symptoms. The predominance of habitual snoring among children in general is as high as 28%, which can cause difficulties for the proper diagnosis of OSAS [33,34]. The findings of the current study revealed that 84% of the Saudi children with obesity showed habitual snoring in the past year of more four nights or more per week. This result is in accordance with the studies of Ali, *et al.* [35] and Marcus, *et al.* [36] who reported about 65 - 80% of obese children snored regularly.

Obstructive Apnea-Hypopnea Index (OAHl) is considered a measure of OSAS severity [15]. The results of the present work demonstrated that the mean OAHl was high (More than 6) with the male subjects higher than the females but not statistically significant. Peppard,

*et al.* [24] 4-year study illustrated that 10% weight gain in children leads to 32% increase in OAH and on the other hand a 10% loss in weight caused a 26% decrease in OAH score. Significant studies showed the strong association between OSAS and obesity in children and demonstrated that weight loss induced by diet, physical activity or even by bariatric surgery could predict a reduction of the symptoms of OSAS such as excessive daytime sleepiness [16,37,38].

### Conclusion

To conclude, the present work showed that the occurrence of obesity among Saudi children could be a risk factor of SDB. The most common type of SDB associated with obesity was hypopnea followed by OSAS. The BMI did not correlate with the severity of OSAS in the studied obese children. The results of the current study might suggest the need for further wider studies to study the role of SDB among Saudi children in overweight and obesity.

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### Conflicts of Interest

All authors disclose any and all conflicts of interest with publication of the manuscript or an institution or product that is mentioned in the manuscript. Authors disclose conflict of interest with products that compete with those mentioned in the manuscript.

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