Obstructive Sleep Apnea in Children: Diagnostic Pattern, Treatment Outcomes, and Positive Airway Pressure Therapy Barriers at a Tertiary Center in Oman

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Abstract

Objectives: In children, obstructive sleep apnea (OSA) negatively impacts cognitive, behavioral, and physical health. While widely studied globally, treatment adherence remains a challenge. This study aimed to retrospectively analyze pediatric polysomnography data from 2015 to 2019, examining the types of sleep studies performed and the severity of OSA across pediatric age groups at Sultan Qaboos University Hospital (SQUH). It also evaluated treatment strategies, with a focus on the acceptance, adherence, and barriers to positive airway pressure (PAP) therapy.

Methods: A retrospective review was conducted from January 2015 to December 2019. Data from 290 pediatric patients (1 week old to 12 years old) who had diagnostic sleep studies at SQUH were analyzed. Variables assessed included demographics, OSA severity, treatment modalities, and PAP therapy adherence outcomes.

Results: Of the 290 patients (189 males [65.2%]), OSA was diagnosed in 249 (85.9%), with severe OSA in 167 (67%). Multivariable logistic regression identified obesity (OR 3.08, 95% CI 1.61–5.86, p=0.0006) and Trisomy 21 (OR 3.19, 95% CI 1.29–7.92, p=0.012) as independent predictors of severe OSA, while younger age was associated with increased severity (OR 0.87 per year, 95% CI 0.80–0.94, p=0.0007).
PAP therapy was recommended for 100 patients, initiated in 82, and accepted by 55 (67%). Among those, 38 (69%) achieved adherence. Major barriers included pressure intolerance, child refusal, and caregiver-related challenges.

Conclusions: Severe OSA was highly prevalent among pediatric patients undergoing sleep studies, indicating a substantial disease burden. Despite clear recommendations, PAP adherence remained suboptimal, with pressure intolerance and caregiver-related factors as key barriers. Obesity and Trisomy 21 were significant contributors to disease severity. Tailored, multidisciplinary interventions are essential to improve PAP adherence and optimize pediatric OSA management.

Keywords: Obstructive Sleep Apnoea; Obesity; Trisomy 21; PAP Adherence.

Introduction

Sleep is a critical component for healthy development in children, influencing various aspects of cognitive, emotional, and physical growth. Disruptions in sleep, particularly from conditions such as obstructive sleep apnea (OSA), have been shown to negatively affect neurocognitive development, behavior, and overall

well-being in pediatric populations.[1–3] OSA is characterized by repetitive episodes of partial or complete upper airway obstruction during sleep, leading to intermittent hypoxia, fragmented sleep, and impaired restorative sleep processes.[4]

While global studies have detailed pediatric OSA prevalence and management, data on treatment adherence and outcomes remain scarce. Pediatric OSA is managed globally with well-established protocols involving diagnostic polysomnography (PSG) and interventions ranging from surgical procedures to non-invasive therapies such as positive airway pressure (PAP). However, in some communities, the management of pediatric OSA faces unique challenges, including delayed diagnosis and limited access to treatment.

OSA is often associated with comorbidities such as obesity, Trisomy 21, craniofacial anomalies and other genetic disorders. These conditions exacerbate the risk of OSA and complicate its management. Recent studies highlight that obesity is one of the most significant risk factors for pediatric OSA. Increased fat deposition in the upper airway leads to airway narrowing and collapsibility, exacerbating sleep-disordered breathing.[5]

Furthermore, childhood obesity-related metabolic dysregulation influences systemic inflammation, which has been linked to increased OSA severity.[6] These findings underscore the urgent need for weight management strategies as part of OSA prevention and treatment.

Adenotonsillectomy remains the primary surgical intervention, in cases of adenoid and tonsillar hypertrophy while positive airway pressure (PAP) therapy is essential for persistent or complex cases, though adherence challenges persist especially in pediatric population.[3,7] Factors influencing poor adherence include intolerance with pressure, psychological resistance, lack of caregiver understanding and engagement, and technical difficulties in managing the equipment.[8]

The establishment of a Level 1 pediatric sleep study unit at Sultan Qaboos University Hospital (SQUH) in 2015 marked a significant milestone in Oman's healthcare landscape. This facility, developed in accordance with international standards, became the first of its kind in the country dedicated to the diagnosis and management of pediatric sleep disorders, particularly sleep-disordered breathing (SDB). Limited regional data exist on pediatric OSA prevalence, severity, and treatment adherence in the Middle East, particularly in Oman. To address this gap, the present study retrospectively analyzes five years of data from the country's pioneering Level 1 pediatric sleep laboratory, with the dual objectives of evaluating OSA prevalence and severity and identifying key barriers to the effective implementation and adherence of PAP therapy. The findings aim to generate evidence that can inform targeted interventions and guide the future development of pediatric sleep medicine both within Oman and the broader middle eastern region.

Methods

All pediatric patients (1 week old to 12 years old) who underwent diagnostic sleep studies at Sultan Qaboos University Hospital (SQUH) during the study period were eligible for inclusion. Patients were included if their medical records contained complete demographic, clinical, and polysomnographic data. Patients with incomplete or missing key variables were excluded to ensure data accuracy and consistency.

Data were extracted from the hospital's electronic medical record (EMR) system. Variables collected included age, sex, sleep study findings, OSA severity, comorbid conditions, and treatment modalities (both surgical and non-surgical).

OSA severity was categorized and classified based on the Obstructive Apnea–Hypopnea Index (OAHI) using American Academy of Sleep Medicine (AASM) guidelines. This classification system has been validated in recent studies and is widely used to guide clinical decision-making and predict outcomes.[10]

The use of PAP therapy was recorded, including whether therapy was recommended, initiated, accepted, and adhered to. Acceptance was defined as agreement to continue PAP therapy for home use after initiation. Adherence was defined as usage of >4 hours per night on ≥70% of nights over a consecutive 30-day period, in accordance with AASM guidelines.[9] Adherence data were obtained from device download reports, providing objective measures of therapy compliance.

The study protocol was reviewed and approved by the Ethics Committee of the College of Medicine and Health Sciences at Sultan Qaboos University. All medical records were identified prior to analysis to ensure patient confidentiality and compliance with ethical standards.

Descriptive statistics were used to summarize demographic data, OSA diagnoses, treatment modalities, and PAP therapy adherence rates. Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables were analyzed using the independent samples t-test or Mann–Whitney U test based on data distribution.

Multivariable logistic regression analysis was performed to identify independent predictors of severe OSA. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs)**.** A p-value <0.05 was considered statistically significant. All statistical tests were two-tailed.

This study was approved by the Ethics Committee of the College of Medicine and Health Sciences at Sultan Qaboos University (MREC #2457). All medical records reviewed in this study were de-identified prior to analysis to ensure patient confidentiality.

Results

A total of 290 pediatric patients underwent sleep studies at Sultan Qaboos University Hospital (SQUH). The cohort comprised 189 males (65.2%) with the majority 160 (55.2%) aged 5-12 years. Obstructive sleep apnea (OSA) was diagnosed in 249 patients (85.9%), with severe OSA being the most prevalent 167 (67%) [Table 1].

Table 1: Patients' characteristics and demographic.

Characteristic	Details	Percentage
Total Number	290	
Gender Distribution		
- Male	189	65.2%
- Female	101	34.8%
Age Categories		
- Infant (< 1 year)	23	7.9%
- Toddler (1-2 years)	58	20.0%
- 2-5 years	49	16.9%
- >5-12 years	160	55.2%

The distribution of OSA severity varied significantly across age groups. Infants (<1 year) and toddlers (1–2 years) exhibited the highest proportions of severe OSA, with 21 (91.3%) and 42 (72.4%) of cases, respectively, classified as severe. Among preschool-aged children (2–5 years), severe OSA was observed in 31 (63.3%) of cases. In school-aged children (5–12 years), OSA severity was evenly distributed, with 73 (45.6%) classified as severe and a higher proportion presenting with mild to moderate OSA [Table 2]. Notably, while infants demonstrated the highest overall OSA diagnosis rate 21 (91.3%), severe OSA remained prominent in older children, particularly those aged 5–12 years.

Table 2: The severity of OSA among children based on age group.

Age Group	Total (n)	Normal	Mild OSA	Moderate OSA	Severe OSA
Infants (<1 yr)	23	1 (4.3%)	1 (4.3%)	0%	21 (91.3%)
Toddlers (1–2 yrs)	58	8 (13.8%)	3 (5.2%)	5 (8.6%)	42 (72.4%)
Preschool (2–5 yrs)	49	5 (10.2%)	8 (16.3%)	5 (10.2%)	31 (63.3%)
School-age (5–12 yrs)	160	19 (11.9%)	39 (24.4%)	29 (18.1%)	73 (45.6%)

OSA: Obstructive sleep apnea.

Of the 249 patients diagnosed with obstructive sleep apnea (OSA), 41 had surgical interventions prior to the sleep study, predominantly adenotonsillectomy. Following the sleep study, surgical interventions were performed in 53 patients, with adenotonsillectomy remaining the most commonly performed procedure [Table 3**].**

Table 3: Summarizing the type of surgical interventions performed on patients with OSA:

Type of Intervention	**Number of Patients**
Adenoidectomy	10
Tonsillectomy	2
Adenotonsillectomy	43
Revised adenoidectomy	8
Tracheostomy	7
Oro-maxillary surgery	4

Obesity was significantly associated with OSA severity, with 42 of 69 obese patients (60.8%) classified as having severe OSA. Additional comorbidities were also linked to disease severity: Trisomy 21 was present in 34 patients (27 with severe OSA) and asthma in 63 patients (37 with severe OSA) [Table 4].

Table 4: Association of obesity and comorbidities (trisomy 21 and asthma) with OSA severity in the study cohort.

Category	**Comorbidity**	**Number**
Obesity-related		
	Obesity	69
	Prader-Willi Syndrome (PWS)	5
	Bardet-Biedl Syndrome	2
Syndromic/Genetic		
	Craniofacial Syndrome	9
	Metabolic Conditions (e.g. MPS)	8
	Neurometabolic Disorders	6
	Chromosomal Deletion	1
	Genetic Causes	47
	Down Syndrome	34
	Pyknodysostosis Syndrome	2
	Sanjad-Sakati Syndrome	6
Lung-related		
	Airways Malacia	2
	Bronchiectasis	2
	Childhood Interstitial Lung Disease (chILD)	1
	Asthma	63
Cardiac	Cardiomyopathy	5
Endocrine	Hypothyroidism	5
Developmental/Psychiatric		
	Developmental Delay	37
	Autism	2
	Attention Deficit Hyperactivity Disorder (ADHD)	7

The total number of comorbidities exceeds the total number of patients, as some patients had more than one comorbid condition.

Multivariable logistic regression analysis was performed to identify independent predictors of severe obstructive sleep apnea (OSA). Variables included in the regression model were age, obesity and Trisomy 21 based on clinical relevance and prior literature.

Younger age was significantly associated with increased odds of severe OSA (OR 0.87) per year increase, 95% CI 0.80–0.94, p=0.0007), indicating that the likelihood of severe disease decreases with increasing age.
Obesity was a strong independent predictor, with obese children having approximately threefold higher odds of severe OSA compared to non-obese children (OR 3.08, 95% CI 1.61–5.86, p=0.0006).
Trisomy 21 was also independently associated with severe OSA (OR 3.19, 95% CI 1.29–7.92, p=0.012). (Table: 5).

Table 5: Multivariable Logistic Regression Analysis of Predictors of Severe Pediatric Obstructive Sleep Apnea.

Variable	OR	95% CI	p-value	Interpretation
Age	0.87	0.80 – 0.94	0.0007	Younger age → higher risk
Trisomy 21	3.19	1.29 – 7.92	0.012	Significant predictor
Obesity	3.08	1.61 – 5.86	0.0006	Strong predictor

PAP therapy was recommended for 100 patients, of whom treatment was initiated in 82 patients. Among these, 55 patients accepted therapy (acceptance rate 67%). Adherence—defined as usage >4 hours/night on ≥70% of nights over 30 consecutive days—was achieved in 38 patients (69% of those who accepted; 46% of those who initiated therapy). Barriers to initiation and adherence included clinical improvement, transfer of care, financial constraints, pressure intolerance, and refusal by the child or caregivers [Figure 1–3].

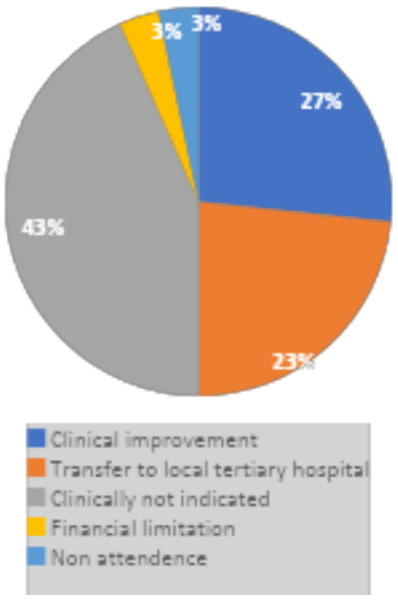

Figure 1: Primary barriers to initiating positive airway (PAP) therapy among pediatric OSA patients moderate OSA.

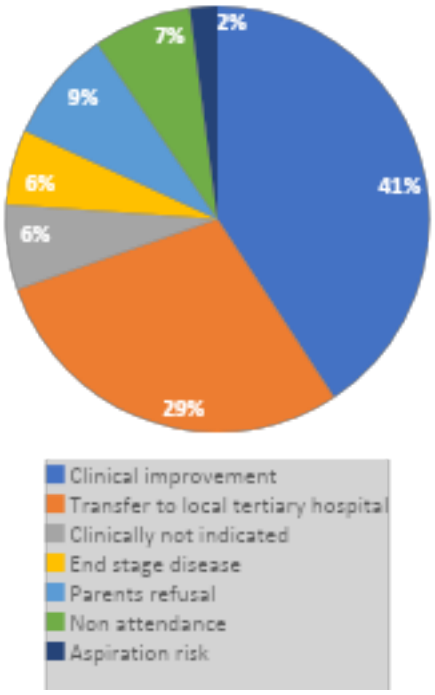

Figure 2: Primary barriers to initiating PAP therapy among pediatric OSA patients severe OSA.

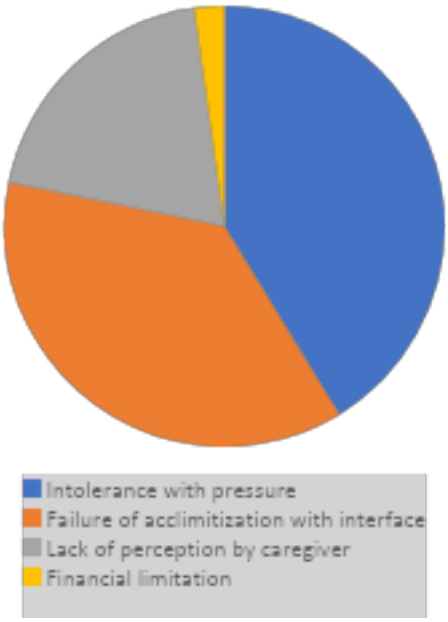

Figure 3: Reasons for non-compliance with PAP therapy in overall cohort of patients who were started on CPAP therapy.

Discussion

The findings from our study provide valuable insights into the burden, severity, and management of pediatric obstructive sleep apnea (OSA) at Sultan Qaboos University Hospital (SQUH), the only center in Oman offering comprehensive pediatric sleep medicine services. The high proportion of severe OSA cases observed in our cohort (167 patients, 67%) appears greater than the prevalence reported in the general pediatric population (1–13%).[11] This discrepancy is likely attributable to the role of our institution as a tertiary referral center, resulting in a higher concentration of complex and severe cases.

The distribution of OSA severity across pediatric age groups observed in our study is consistent with existing literature, highlighting the increased vulnerability of younger children to severe OSA. Specifically, infants (<1 year) and toddlers (1–2 years) exhibited the highest proportions of severe OSA, affecting 21 patients (91.3%) and 42 patients (72.4%), respectively. These findings are supported by previous studies demonstrating that younger children are more susceptible to severe OSA because of anatomical and developmental factors.[10] This trend is further reinforced by reports showing that children aged 1–5 years are at significantly increased risk of moderate-to-severe OSA, with one study reporting an odds ratio of 6.16 for this age group.[10]

The high prevalence of severe disease in younger children is primarily attributed to adenotonsillar hypertrophy, which peaks between the ages of 2 and 6 years and contributes to upper airway obstruction during sleep.[12]

In contrast, school-aged children (5–12 years) demonstrated a broader distribution of OSA severity, with 73 patients (45.6%) classified as having severe OSA and higher proportions of mild and moderate disease. This shift may reflect the relative regression of lymphoid tissue with age, along with the increasing contribution of other risk factors, particularly obesity, in older children.

The significant variation in OSA severity across age groups highlights the need for age-specific screening and intervention strategies. Early identification and treatment of severe OSA in children are crucial to prevent complications such as behavioral disturbances, cardiovascular morbidity, and impaired growth.[1]

The higher prevalence of obesity among older children may further exacerbate airway obstruction through increased fat deposition around the upper airway and reduced neuromuscular compensation.[13] Our findings align with current evidence indicating that obesity markedly increases the risk of severe OSA.[10,14] A multicenter cohort study involving 818 children referred for sleep studies reported that 66.3% had moderate-to-severe OSA, with obesity identified as an independent predictor that more than doubled the risk (OR 2.08; 95% CI: 1.35–3.19).[10] Similarly, another study demonstrated that 53% of severely obese children had severe OSA, compared with 33% of children with less severe obesity, underscoring the strong association between obesity severity and OSA severity.[15] These findings emphasize the importance of early identification and targeted management of OSA in obese children. Our results further confirm that obesity and Trisomy 21 are major independent contributors to severe pediatric OSA, consistent with international literature.[25]

In our cohort, adenotonsillectomy was the most commonly performed surgical procedure, undertaken in 43 patients. This finding aligns with established clinical guidelines recommending adenotonsillectomy as first-line therapy for children with significant adenotonsillar hypertrophy.[1] Nevertheless, persistent OSA following surgery, particularly among children with comorbidities such as obesity and Trisomy 21, highlights the need for ongoing monitoring and consideration of adjunctive therapies such as positive airway pressure (PAP) therapy.[3]

Our study also highlights the challenges associated with adherence to PAP therapy in pediatric populations. Although PAP therapy remains the gold-standard non-surgical treatment for OSA, adherence in our cohort was observed in 38 patients (69%), which is comparable to rates reported in other pediatric studies.[8,16] While a 30-day adherence period provides a standardized method for assessment; however, longer-term monitoring is necessary, particularly in pediatric population.

Barriers to PAP adherence included intolerance with positive airway pressure, failure of acclimatization with interface, and caregiver-related challenges, all of which are commonly reported in pediatric OSA management.[16–19] Behavioral interventions, including motivational interviewing and positive reinforcement strategies, have been shown to improve adherence by addressing psychological resistance and parental concerns.[8,20] In addition, the use of child-friendly PAP interfaces and desensitization programs has been associated with greater acceptance and sustained therapy use.[19] Incorporating such strategies into clinical practice may improve adherence rates and enhance long-term treatment outcomes in children with OSA.

The comorbidities identified in our cohort including obesity and Trisomy 21 are well-established risk factors for both the development and exacerbation of OSA. Children with Trisomy 21, in particular, are at substantially increased risk of severe OSA. In our study, 27 of 34 patients (79%) with Trisomy 21 were diagnosed with severe disease. This increased vulnerability is attributed to craniofacial abnormalities, including macroglossia and midface hypoplasia, upper airway hypotonia, and adenotonsillar hypertrophy, all of which contribute to persistent airway obstruction.[21–23]

Given this high disease burden, early screening and intervention are essential. Current recommendations advocate universal polysomnography screening by the age of four years, even in asymptomatic children with Trisomy 21, to facilitate timely diagnosis and treatment initiation.[24] Furthermore, a multidisciplinary approach involving pediatric pulmonologists, otolaryngologists, sleep specialists, and geneticists is essential for optimizing patient outcomes. In addition to surgical management, adjunctive interventions such as myofunctional therapy, CPAP desensitization programs, and caregiver education may further improve long-term outcomes in this vulnerable population.[4]

Future research should explore tailored intervention programs aimed at addressing caregiver concerns and improving treatment acceptance among young children. In addition, the development of multidisciplinary care teams to support both surgical and non-surgical management strategies may further enhance overall treatment outcomes.

This study has several limitations. As a retrospective analysis, it may be subject to selection bias, and reliance on medical records may not fully capture patient-reported outcomes or actual adherence behaviors. In addition, key sociodemographic variables, including caregiver education, family structure, and household size, were not consistently documented and therefore could not be analyzed. The retrospective design was selected to enable efficient analysis of existing data while maintaining patient confidentiality. Despite these limitations, retrospective studies remain valuable for identifying clinical trends and informing future research directions. Prospective studies with inclusion of patient-reported outcomes are needed to validate and expand upon our findings regarding pediatric sleep disorders and treatment adherence.

The findings from our study provide valuable insights into the burden, severity, and management of pediatric obstructive sleep apnea (OSA) at Sultan Qaboos University Hospital (SQUH), the only center in Oman offering comprehensive pediatric sleep medicine services. The high proportion of severe OSA cases observed in our cohort (167 patients, 67%) appears greater than the prevalence reported in the general pediatric population (1–13%).[11] This discrepancy is likely attributable to the role of our institution as a tertiary referral center, resulting in a higher concentration of complex and severe cases.

Conclusion

In conclusion, our study highlights the substantial burden of pediatric OSA in Oman. Adenotonsillectomy remains the primary intervention; however, persistent OSA and challenges related to PAP adherence, especially among children with comorbidities underscore the need for multidisciplinary and individualized care. Future research should focus on strategies to sustain PAP adherence including structured caregiver education, motivational and positive reinforcement strategies, role of play therapist, pediatric friendly interfaces, and role of telemedicine in adherence monitoring to improve long-term compliance. Public health initiatives targeting childhood obesity are also essential to reduce the prevalence and severity of pediatric OSA.

Disclosure

The authors declare no affiliations with or involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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