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ORIGINAL RESEARCH

Clinical Evaluation of Sleep Disorders in Childhood: A Polysomnography-Based Study

Sarra Elhamida LAZRAK[1], Aylin BİCAN DEMİR[1], Furkan SARIDAŞ[1], Erdal EREN[2], Yakup CANITEZ[3], Merve KORKMAZ[4]

[1] Bursa Uludag University Faculty of Medicine, Neurology Department, Bursa, Türkiye.
[2] Bursa Uludag University Faculty of Medicine, Department of Pediatric Endocrinology, Bursa, Türkiye
[3] Bursa Uludag University Faculty of Medicine, Department of Pediatric Allergy, Pediatric Pulmonary Diseases, Pediatric Immunology, Bursa, Türkiye.
[4] Bursa Uludag University Faculty of Medicine, Department of Pediatric Pulmonary Diseases, Bursa, Türkiye.

ABSTRACT

Obstructive Sleep Apnoea Syndrome (OSAS) is increasingly recognised in the paediatric population. It is important to consider that certain pulmonary and endocrinological disorders may be influenced by OSAS or exhibit a more severe clinical course due to the presence of OSAS. This study aims to highlight the application of polysomnography in the paediatric population, particularly in the diagnosis and treatment of sleep disorders associated with chronic comorbidities—most notably endocrinological and respiratory conditions—and to emphasise the importance of improving quality of life measures to support healthy development in affected children.

Polysomnography (PSG) recordings obtained between January 2020 and April 2025 at the Sleep Disorders Unit of the Department of Neurology, Faculty of Medicine, Bursa Uludag University, were retrospectively reviewed. Among these PSG records, patients referred from the Departments of Paediatric Endocrinology and Metabolism, Paediatric Pulmonology, and Paediatric Immunology and Allergy were identified. Demographic data, medical history, and PSG findings of the included patients were analysed.

The results of polysomnography (PSG) performed in our center showed that the incidence of obstructive sleep apnea syndrome (OSAS) in children with endocrinologic or respiratory diseases was higher (25.7% vs. 3%) and the mean age was older (7 years vs. 4 years) compared to the normal pediatric population. The prevalence of sleep disorders was similar in these patients and normal children (54.4% vs. >50%), as was the prevalence of central apnea (2.9%). There were no gender differences among patients with sleep disorders.

Keywords: Sleep Disorders. Childhood. Polysomnography. Endocrinologic Disorders. Respiratory Diseases.

Çocukluk Çağında Uyku Bozukluklarının Klinik Değerlendirilmesi: Polisomnografi Temelli Çalışma

ÖZET

Obstrüktif uyku apne sendromu (OSAS) pediatrik popülasyonda giderek daha fazla tanınmaktadır. Bazı pulmoner ve endokrinolojik bozuklukların OSAS'tan etkilenebileceği veya OSAS'ın varlığı nedeniyle daha şiddetli bir klinik seyir gösterebileceği dikkate alınmalıdır. Bu çalışmada pediatrik yaş grubunda polisomnografi uygulaması, kronik komorbiditelerde özellikle endokrinolojik ve solunum yolu hastalıklarında uyku bozukluklarının tanısı konulması, tedavi edilmesi ve hastaların sağlıklı gelişimi için yaşam kalitesi iyileştirme önemlerinin vurgulanması amaçlanmıştır.

Bursa Uludağ Tıp Fakültesi Nöroloji Anabilim Dalı, Uyku Bozukluklarının Birimi, Ocak 2020 ile Nisan 2025 tarihleri arasında yapılan PSG kayıtları geriye dönük olarak incelendi. Yapılan PSG kayıtları arasında Pediatrik Endokrinoloji ve Metabolizma, Pediatrik Göğüs hastalıkları ve Pediatrik İmmünoloji ve Alerji bölümlerinden yönlendirilen hastalar araştırıldı.

Bizim merkezde yapılan PSG sonuçlarında endokrinolojik veya solunumsal hastalığı eşlik eden çocuklarda OSAS'ın görülme sıklığı normal pediatrik popülasyonuna göre daha yüksek (%25.7 vs %3), ortalama yaşı daha büyük (7yaş vs 4yaş) saptanmıştır. Bu hastalar ve normal çocuklarda uyku bozuklukları görülme oranı benzer (%54,4 vs >%50), santral apne sıklığı ise literatürden farksız saptanmıştır (%2.9). Uyku bozukluğu olan hastalarda cinsiyet farkı görülmemiştir.

Anahtar Kelimeler: Uyku Bozuklukları. Çocukluk Çağı. Polisomnografi. Endokrinolojik Bozukluklar. Solunum Hastalıkları.

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Dr. Sarra Elhamida LAZRAK
Bursa Uludag University Faculty of Medicine,
Neurology Department, Bursa, Türkiye
sarralazrak@uludag.edu.tr

AUTHORS' ORCID INFORMATION
Sarra Elhamida LAZRAK: 0000-0001-5596-5246
Aylin BİCAN DEMİR: 0000-0001-6739-8605
Furkan SARIDAŞ: 0000-0001-5945-2317
Erdal EREN: 0000-0002-1684-1053
Yakup CANITEZ: 0000-0001-8929-679X
Merve KORKMAZ: 0000-0002-1313-0854

Sleep plays a crucial role in sustaining the body's energy balance, supporting physical and cognitive development, maintaining emotional well-being, and enhancing memory and attention. The most widely recognised consequence of insufficient sleep is daytime sleepiness. However, in children, sleep deprivation more commonly manifests as irritability, behavioural problems, learning difficulties, motor vehicle accidents in adolescents, and reduced academic performance[1].

Sleep problems are common among children and, depending on the specific definition employed, affect approximately 20–30% of those under the age of 12, rising to as much as 50% during adolescence—most often due to sleep deprivation. The estimated prevalence of sleep disorders requiring medical intervention ranges between 10% and 20%. Nevertheless, due to the limited knowledge many paediatricians possess regarding sleep-related issues, these conditions are frequently overlooked and consequently underdiagnosed[2,3].

Sleep disorders are more frequently observed in children with acute or chronic medical conditions compared to their healthy peers. Obstructive Sleep Apnoea Syndrome (OSAS), in particular, has been reported to have a high prevalence among patients with metabolic syndrome or endocrine disorders. Sleep apnoea is commonly observed in various endocrine conditions such as acromegaly, Cushing's disease (CD) and Cushing's syndrome (CS), hypothyroidism, and diabetes mellitus[4].

The prevalence of sleep-related symptoms increases in patients with chronic obstructive airway diseases, particularly among those with coexisting asthma and chronic bronchitis[5].

Chronic allergies are associated with sleep disturbances and are recognised as a known risk factor for sleep-disordered breathing, including habitual snoring, obstructive sleep apnoea, and adenoidal hypertrophy resulting from the chronic effects of inflammation[6,7].

Polysomnography (PSG) is considered the gold standard for the diagnosis of paediatric obstructive sleep apnoea syndrome (OSAS). Normative values for polysomnographic parameters in children have been established through methodological studies. Considering age-appropriate reference ranges, polysomnographic evaluation can be reliably conducted in the paediatric population.

In the current study,we aimed to retrospectivley examine the results of children who were assessed using polysomnography in the Sleep Laboratory in our Medical Faculty Hospital and, highlight the importance of the application of polysomnography in the paediatric population, particularly in children with endocrinological and respiratory conditions; notably in the presence of symptoms of obstructive sleep apnea syndrome (OSAS) or any other sleep-related complaints, since the risk of OSAS could be high in this population. Diagnosing OSA in these patients is very important, as it positively affects the prognosis of the underlying disease and can help improve the quality of life in every aspect of the affected children.

Material and Method

Polysomnography (PSG) recordings obtained between January 2020 and April 2025 at the Sleep Disorders Unit of the Department of Neurology, Faculty of Medicine, Bursa Uludag University, were retrospectively reviewed. Among these PSG records, patients referred from the Departments of Paediatric Endocrinology and Metabolism, Paediatric Pulmonology, and Paediatric Immunology and Allergy were identified. Demographic data, medical history, and PSG findings of the included patients were analysed. The inclusion criteria were: being under the age of 18, having a diagnosed endocrinological or respiratory condition, and presenting with sleep-related complaints. The exclusion criteria included: a diagnosis of neurological disease, severe intellectual disability, or a history of acute infection or exacerbation of an underlying illness.

The local ethics committee approved the study (Uludag Faculty of Medicine, number 653-9/16). All methods were performed in accordance with the relevant guidelines and regulations.

The International Classification of Sleep Disorders – Third Edition, Text Revision (ICSD-3-TR) Criterion was utilised in the diagnosis of Sleep Disorders.

The severity of obstructive sleep apnoea was determined based on the Apnoea–Hypopnoea Index (AHI), with AHI values of 5–15 classified as mild OSAS, 16–29 as moderate OSAS, and >30 as severe OSAS.

Results

The study included a total of 35 paediatric patients, comprising 13 girls and 22 boys. The mean age of the patients was 8.89 years (range: 3–17 years). Eighteen patients were followed up by the Department of Paediatric Endocrinology and Metabolism, while seventeen patients were under the care of the Departments of Paediatric Pulmonology and Paediatric Immunology and Allergy.

Comorbid conditions observed in the patient cohort included obesity (25.7%), achondroplasia (14.3%), Duchenne muscular dystrophy (11.4%), Prader–Willi syndrome (5.7%), scoliosis (5.7%), craniopharyngioma (2.9%), attention deficit

hyperactivity disorder (2.9%), epilepsy (2.9%), adrenoleukodystrophy (2.9%), Wolfram syndrome (2.9%), pycnodysostosis (2.9%), and ROHHAD syndrome (2.9%). Polysomnography was performed in these patients due to a preliminary diagnosis of OSAS.

Among the patients, the following diagnoses were established: normal sleep architecture (42.9%), obstructive sleep apnoea syndrome (OSAS) (25.7%), primary snoring (8.6%), reduced sleep efficiency (8.6%), positional OSAS (5.7%), and REM-related sleep apnoea (2.9%).

In patients diagnosed with OSAS, the mean Apnoea–Hypopnoea Index (AHI) was measured as 16.98. The mean minimum oxygen saturation was 90.06%, sleep efficiency was 84.02%, and sleep latency was 26.77 minutes. The distribution of sleep stages was as follows: NREM Stage 1 – 2.44%, Stage 2 – 38.24%, Stage 3 – 41.70%, and REM sleep – 17.77%. (Table I)

Table I. Demographic and clinical polysomnography parameters of the study cohort.

		Average (ss)	Median (min-max)
Sex		1.62 (0.49)	2 (1-2)
Age		8.89 (4.24)	7 (3 - 17)
Sleep Efficiency%		84.02 (17.89)	93.1 (21.5 – 99.8)
Sleep Latency (min)		26.77 (32.34)	10.75 (1 – 104.5)
NREM Stage 1 %		2.44 (1.68)	2 (0.1 - 9)
Stage 2 %		38.24 (11.4)	38 (17 – 56.1)
Stage 3 %		41.7 (10.47)	41.8 (15.2 – 73.3)
REM %		17.71 (11.21)	17.05 (0.8 – 56.5)
MİN O2 SAT		90.06 (4.07)	91.5 (78 - 98)
AHI		16.9778	13.5 (4.3-44.2)
Comorbidities	Obesity	9 (%25.7)	
	ROHHAD	1 (%2.9)	
	Prader willi	2 (%5.7)	
	Achondroplasia	5 (%14.3)	
	DMD	4 (%11.4)	
	Craniopharyngioma	1 (%2.9)	
	ADHD	1 (%2.9)	
	Pycnodysostosis	1 (%2.9)	
	Epilepsy	1 (%2.9)	
	Wolfram	1 (%2.9)	
	Scoliosis	2 (%5.7)	
	Adrenoleukodystrophy	1 (%2.9)	
Requested department		Respiratory Diseases 17 (%48.6), Endocrinology 18 (%51.4)	
PSG RESULTS	Central Apnea	1(%2.9)	
	OSAS	9 (%25.7)	
	REM releated OSAS	1 (%2.9)	
	Normal	15 (%42.9)	
	Simple snoring	3 (%8.6)	
	Positional sleep apnea	2 (%5.7)	
	Low Sleep Efficiency	3 (%8.6)	

Discussion and Conclusion

Sleep is an integral component of human life. In children, in particular, it is closely associated with a number of vital functions, including (1) neurological growth and development[8], the regulation of physiological processes such as appetite, nutrition, and emotional states[9], the maintenance of adequate immune function, and (4) the enhancement of learning, memory, and attention span[10].

Sleep is categorised into two types based on its behavioural and physiological characteristics: non-rapid eye movement (NREM) sleep—which consists of three stages (N1, N2, N3)—and rapid eye movement (REM) sleep, which is characterised by muscle atonia and a desynchronised electroencephalogram (EEG) pattern. The circadian rhythm of the sleep–wake cycle is regulated by the master clock located in the suprachiasmatic nuclei of the hypothalamus. The neuroanatomical substrates of NREM sleep are primarily situated in the ventrolateral preoptic nucleus of the hypothalamus, whereas those of REM sleep are located in the pons. As a result of functional changes in both the autonomic and somatic nervous systems, various significant physiological alterations occur in organ systems throughout the body during sleep[11].

OSAS can lead to significant alterations in the serum levels or secretion patterns of various hormones, and, in some cases, undiagnosed apnoea may underlie endocrine disorders[12].

The prevalence of childhood obesity is estimated to be approximately 17%, including around 8% among children aged 2–5 years and 20% among those aged 12–19 years. OSAS is recognised as a significant complication of obesity[12].

Fat distribution plays a particularly important role in obesity; neck circumference, as an indicator of fat accumulation around the upper airway, has been found to be a better predictor of OSAS than body mass index (BMI)[13].

The pathophysiology of obesity-related OSA is multifactorial. Fat deposits in the lateral walls of the pharynx reduce the calibre of the upper airway and increase its collapsibility[14].

In addition, the upper airway (UA) dilator muscles—particularly the genioglossus—are mechanically compromised and more prone to fatigue in obese patients[15].

The association between obesity and sleep apnoea cannot be explained solely by fat accumulation in the neck region; it may also be linked to visceral obesity[16] and insulin resistance[17]. Metabolic syndrome is up to nine times more prevalent in individuals with OSAS, and independent of obesity, elevated levels of proinflammatory cytokines such as interleukin-6 (IL-

6) and tumour necrosis factor-alpha (TNF-α) may exacerbate the cardiovascular consequences of OSAS[18].

Achondroplasia is the most common skeletal dysplasia. In addition to short stature, affected individuals typically present with macrocephaly and facial hypoplasia—particularly involving the mandible—as well as abnormal musculoskeletal growth, which may result in neurological and cardiorespiratory complications[19]. Children with achondroplasia frequently experience breathing difficulties, particularly during sleep. Contributing factors that predispose to sleep-disordered breathing include midface hypoplasia, cranial base dysplasia, and cervical stenosis, which is responsible for spinal cord compression[20].

Another rare endocrine disorder frequently accompanied by sleep apnoea is paediatric gigantism. This condition is characterised by thickening of connective tissue, which is associated not only with glycosaminoglycan accumulation and increased collagen production but also with tissue oedema. The oedema may result from enhanced renal sodium reabsorption by distal renal tubules, secondary to direct stimulation of the epithelial sodium channel by growth hormone (GH) and insulin-like growth factor I (IGF-I). As a consequence, anatomical alterations occur in craniofacial bones, soft tissues, and the respiratory mucosa, frequently leading to the development of OSAS[21-24].

Hypothyroidism and obstructive sleep apnoea (OSA) are both common in the general population and exhibit certain overlapping clinical features.

In hypothyroidism, the primary pathophysiological mechanism of OSA is the narrowing of the pharyngeal airway due to mucopolysaccharide and protein infiltration into the skin and soft tissues[25]. Even in the absence of hypothyroidism, goitres may contribute to pharyngeal obstruction and the development of OSA[26].

There is growing evidence that untreated sleep disorders during childhood may increase the risk of obesity and metabolic syndrome later in life. Sleep deprivation and disruption of sleep architecture may disrupt the regulatory balance of appetite-related hormones, notably ghrelin and leptin, leading to increased appetite and weight gain. In addition, children with OSAS are at greater risk of growth failure, insulin resistance, and long-term cardiovascular complications, including (pulmonary) hypertension in later life [27]. Therefore, early diagnosis and management of sleep disorders are of critical importance in preventing these long-term health outcomes[28,29].

Sleep-disordered breathing (SDB) is observed in more than 40% of patients with neuromuscular disorders (NMD)[30]. Suboptimal ventilation during sleep is a major aetiological factor contributing to abnormal sleep patterns in individuals with NMD. In such conditions, dysfunction in central respiratory control mechanisms, respiratory muscles, the neuromuscular junction, or lower motor neurons may lead to SDB, nocturnal hypoxaemia, hypoventilation, and obstructive sleep apnoea. This, in turn, results in sleep fragmentation and repeated arousals, ultimately contributing to excessive daytime sleepiness, which is the most commonly reported symptom. Additional complications may include obesity, kyphoscoliosis, macroglossia, craniofacial deformities, recurrent respiratory infections, medication effects, and multiorgan dysfunction[31].

Asthma is recognised as the most common non-communicable chronic disease in childhood. The prevalence of sleep problems in children with asthma has been reported to be as high as 60%. The pathophysiology of OSAS in asthma involves the interaction between static factors, such as narrowing of the airway by lymphatic and soft tissues, and dynamic factors, including neuromuscular tone and airway collapsibility[32].

Another immunologically based condition is cystic fibrosis[33], approximately 40% of children and adolescents with CF report sleep-related complaints, and up to 70% of these individuals experience excessive daytime sleepiness[34]. In CF, numerous factors associated with disease activity—such as chronic coughing, inflammation and infection of the upper and lower airways, gastroesophageal reflux, abdominal pain, frequent defaecation, and medication effects—have the potential to disrupt sleep[35,36].

Obstructive sleep apnoea syndrome (OSAS) is increasingly recognised within the paediatric population. It is important to consider that certain pulmonary and endocrinological disorders may be influenced by OSAS or exhibit a more severe clinical course due to its presence.

Polysomnography is the gold standard in the diagnosis of sleep disorders in children. Considering the high prevalence and consequences of untreated OSA; Pediatricians should be able to recognize early signs and symptoms of sleep disorders and refer the patients in risk to centers where evaluation with polysomnography is available.

Sleep disordered breathing is a common problem in childhood that encompasses a spectrum of disorders extending from primary snoring to obstructive sleep apnea. The main reported risk factors for obstructive sleep apnea (OSA) in children are adenotonsillar hypertrophy, obesity, craniofacial anatomical deformities, and neuromuscular diseases. İn our study; we showed a high incidence of obstructive sleep apnea syndrome (OSAS) in children with endocrinologic and

respiratory diseases. Because of the specific target population in our study, our patient number (n=35) is relatively small. Thus; more studies are needed to assess the incidence of sleep-related breathing disorders, particularly OSAS, in pediatric patients with endocrine and respiratory conditions.

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