Archives of Epilepsy

Review

Epilepsy and Respiratory System: A Multidisciplinary Approach to Diagnosis and Treatment - A Literature Review

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Cite this article as: Gökçek Ö, Başer M, Sundu B, Kartal P, Kuş G. Epilepsy and respiratory system: a multidisciplinary approach in diagnosis and treatment - a literature review. *Arch Epilepsy*. 2026;32(2):37-40.

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Received: 31.01.2025 **Accepted:** 23.10.2025 **Epub:** 12.01.2026 **Publication Date:** 12.05.2026
DOI: 10.4274/ArchEpilepsy.2025.25175

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Abstract

Epilepsy is a chronic neurological disorder characterized by recurrent seizures, with a multifactorial etiology. This literature review aims to explore multidisciplinary models for the diagnosis and treatment of epilepsy, with particular focus on the relationship between epilepsy and the respiratory system. In November 2024, we systematically searched Google Scholar and PubMed using the following keywords: "epilepsy" or "seizure", "respiratory system", "hyperventilation", "treatment", "multidisciplinary", "rehabilitation", and "physiotherapy". Epileptic seizures have been shown to affect various physiological systems, including the respiratory system. Specific brain regions involved in seizure activity overlap with areas responsible for respiratory regulation, suggesting a potential bidirectional relationship between seizures and respiratory dysfunction. Respiratory problems induced by seizures may develop into chronic complications and pose serious health risks for individuals with epilepsy. Conversely, pre-existing or seizure-induced respiratory dysfunctions may increase seizure frequency. This review aims to raise awareness of respiratory complications in people with epilepsy and highlights the need for a multidisciplinary approach, including neurology, pulmonology, rehabilitation, and physiotherapy, in the assessment, treatment, and follow-up of these patients. Further research should investigate the effectiveness and structure of multidisciplinary team models in epilepsy care.

Keywords: Epilepsy, respiratory system, physical therapy

INTRODUCTION

Epilepsy is a chronic, non-communicable brain disease that affects approximately 50 million people worldwide.[1,2] It is characterized by an imbalance between excitatory and inhibitory neural activity, resulting in hyperexcitability and recurrent seizures.[3]

Seizures are triggered by abnormal, synchronous neuronal firing in brain networks, often due to structural, infectious, or metabolic abnormalities.[4] Epilepsy affects individuals across all age groups and genders. However, structural-metabolic causes and perinatal trauma are the most frequent etiologies in the 5-9 age group (46%), whereas brain developmental disorders are predominant in children under 4 years (23%). In patients aged 60 and older, cerebrovascular disease accounts for 44% of cases.[5]

Seizures cause a range of physiological responses, with autonomic dysfunction being particularly notable. During a seizure, abrupt activity in central autonomic centers can alter heart rate and respiration. Notably, a decrease in respiratory frequency has been reported, especially in temporal lobe seizures. No significant difference in respiratory rate[6] was observed between left- and right-sided seizures.

The respiratory centers in the brainstem, such as the medulla oblongata and the pons, are susceptible to seizure-induced electrical disturbances. Seizure activity may provoke respiratory changes, particularly in generalized and mesial temporal lobe seizures. These changes include desaturation, obstructive apnoea, hypoventilation, hypercapnia, acidosis, bradypnoea, and tachypnoea.[7]

Although evidence links epileptic seizures to hyperventilation (HV), few studies have comprehensively assessed the respiratory system in patients with epilepsy. Therefore, this review aims to (1) increase awareness of respiratory alterations in epilepsy and (2) emphasize the importance of a multidisciplinary treatment approach.

Epileptic Seizures and Respiratory Function

Epileptic seizures can directly and indirectly influence respiratory function, and conversely, respiratory impairments can exacerbate seizure susceptibility.

Respiratory Effects During and After Seizures

• Respiratory disorders in the ictal period: epileptic seizures have the potential to cause temporary cessation or disorganization of breathing. Especially tonic-clonic seizures,[2] which have a tonic phase followed by clonic muscle contractions, have the potential to obstruct the airways during muscle contraction and thus prevent oxygen intake.[8]

• Respiratory disorders in the postictal period include alterations in respiratory rate and depth following a seizure. Some individuals may experience respiratory pauses, medically termed postictal apnoea, for a few minutes following the seizure.[9]

Respiratory Conditions as Seizure Triggers

• Respiratory tract infections may increase seizure risk through systemic inflammation, fever, hypoxemia, and associated metabolic disturbances. The development of symptomatic seizures in patients with respiratory diseases is associated with blood gas changes, including hypoxemia and respiratory acidosis.[10]

• Reduced oxygen levels (hypoxemia) can impair cerebral function and result in seizures. The clinical manifestations are analogous to those observed in idiopathic epilepsy. However, epileptic seizures associated with acute hypoxia are frequently accompanied by pathological changes, including neuronal ischaemic necrosis and foci of partial cortical softening.[11]

HV and Seizure Activity

HV is defined as rapid breathing, whether deep or shallow that can result in a significant and abnormal decrease in carbon dioxide (CO_2) levels or an increase in blood pH. Although the physiological purpose of HV is to increase oxygen levels, it can cause a sensation of breathlessness or dizziness. In severe instances, it can result in syncope and even loss of consciousness.[12]

Two have been described to explain why HV may trigger seizures in patients with epilepsy. The first mechanism involves cerebral vasoconstriction due to hypocapnia, leading to reduced cerebral blood flow rather than true hypoxia. The second is decreased CO_2 levels in the blood, a condition known as hypocapnia.[13] Indeed, sufficient evidence suggests that such conditions may increase the incidence of epileptic seizures. However, contrary to popular assumptions, the occurrence of HV after exercise is associated with fewer seizures than isolated HV.[14] The underlying reason for this is that the body requires HV as a natural adaptive response to exercise. In summary, the underlying mechanism is different from that of isolated HV.[15]

Respiratory Complications in Epilepsy

The relationship between epilepsy and respiratory function is characterized by a reciprocal and intricate interplay. It is reasonable to conclude that the respiratory issues observed in epilepsy may reflect complex underlying mechanisms. Seizures can directly affect respiration, leading to alterations in respiratory patterns, such as apnoea or oxygen desaturation. In particular, many individuals with epileptic encephalopathy exhibit altered breathing patterns, including periodic and irregular breathing.[16] Central apnoeas, defined as transient cessation of breathing, can occur during seizures or independently, and may contribute to oxygen desaturation and potential respiratory failure.[17] Conversely, respiratory dysfunction, such as chronic hypoventilation, may influence seizure susceptibility and increase the severity of seizures.[18]

The development of hypoventilation, frequently accompanied by hypercapnia (elevated CO_2 levels), can result in chronic respiratory compromise and exacerbate breathing difficulties.[19]

Sudden Unexpected Death in Epilepsy (SUDEP)

SUDEP has an incidence ranging from 0.09 to 9 per 1,000 patient-years, with the highest incidence observed in patients with intractable epilepsy.[20] Both cardiac and respiratory mechanisms play a role in SUDEP.[21] Seizures are associated with hypoxemia.[22,23] Previous studies have shown that the incidence of ictal/postictal hypoxemia is high among patients with localization-related epilepsy who underwent inpatient video-electroencephalography telemetry. In partial-onset seizures,[24] ictal hypoxemia may be severe and prolonged.

Treatment Approaches in Epilepsy and Their Respiratory Implications

Antiepileptic drugs have historically been the primary treatment for epilepsy, aiming to control seizures and reduce their frequency and severity.[11] However, some pharmaceutical agents used in the management of epilepsy may have adverse effects on cardiovascular function and respiration.[6] Several studies have reported that some antiepileptic drugs exacerbate respiratory depression or increase sleepiness, which can lead to irregular breathing patterns.[11] However, the prevalence of drug-resistant epilepsy poses significant challenges for seizure control.[25] Therefore, evaluation of different therapeutic options and approaches is needed.

Today, epilepsy surgery is considered a viable approach for cases where antiepileptic drugs are inadequate. This procedure involves the surgical removal of the epileptogenic focus or lesion, with the objective of achieving seizure freedom, particularly in cases where the lesion is well-defined.[26] Nevertheless, it is imperative to carefully weigh the potential risks of such a procedure, including the possibility of neurological deficits, against the anticipated benefits. It is evident that non-surgical and non-pharmacological methods that carry a reduced risk of complications. These include vagal nerve stimulation (VNS), transcutaneous VNS, deep brain stimulation, trigeminal nerve stimulation, transcranial direct current stimulation, transcranial magnetic stimulation, as well as emerging and experimental approaches such as gene and stem cell therapies.[27] In patients with epilepsy, it is crucial to closely monitor their breathing patterns during any surgical procedure performed under general anesthesia. This is because certain antiepileptic drugs, particularly benzodiazepines, can interact with anesthetic drugs and reduce respiratory function.[28]

Physiotherapy and Multidisciplinary Management

Sleep and respiratory problems, which are frequently reported in patients with epilepsy, significantly affect patients' daily functioning and quality of life. Therefore, epilepsy treatment should not be limited to medical interventions alone; patients should be managed with a multidisciplinary approach. Respiratory rehabilitation is a therapeutic approach that aims to enhance respiratory muscle strength, augment musculoskeletal system endurance, and augment exercise tolerance. It encompasses breathing exercises, strength and flexibility training, aerobic exercise, airway hygiene practices, and energy conservation techniques.

The most commonly prescribed respiratory rehabilitation exercises are breathing exercises, due to their ease of performance, cost-effectiveness, and suitability for the majority of patients. Instruction in posture exercises, effective coughing techniques, energy-conservation techniques, and respiratory-control techniques will facilitate superior rehabilitation outcomes when combined with respiratory exercises tailored to the patient's specific needs.

It is hypothesized that aerobic exercise may reduce respiratory problems by increasing the vital capacity of the lungs. In a published review, aerobic exercise was recommended as a safe form of exercise for individuals with epilepsy.[14] The majority of studies employed an aerobic exercise intensity based on at least 60% of the maximum heart rate, at least 60% of peak VO_2max, or a moderate level on the Graded Perceived Exertion Scale. A published report analyzed specific activities to determine which were safe for patients with epilepsy. Athletic activities, including bowling, judo, wrestling, baseball, basketball, football, volleyball, skiing, and dancing, as well as racquet sports, were identified as safe for patients with epilepsy.[14]

Yoga represents another potential avenue for intervention in patients with epilepsy who present with respiratory complications and other comorbidities. The practice of yoga, which encompasses a range of mental and physical techniques such as meditation and relaxation, has been demonstrated to enhance lung function by fostering increased awareness of breathing.[29]

One of the most significant comorbidities associated with epilepsy is sleep apnea. In addition to conventional treatments, other treatment modalities have been reported in the medical literature. Myofunctional therapy (MT) is a therapeutic modality described in the literature for improving tongue positioning and nasal breathing. There is a substantial body of evidence demonstrating the efficacy of MT in the treatment of sleep apnoea. MT comprises isotonic and isometric exercises for the oral and oropharyngeal structures.[30]

Another method, orofacial MT (OMT), seeks to enhance muscle tone, endurance, and movement capacity of the pharyngeal and peripharyngeal muscles. Recent studies have demonstrated the efficacy of OMT in reducing the incidence of snoring, apnoea, and daytime sleepiness and improving the quality of nocturnal sleep.[31]

DISCUSSION

In studies evaluating respiratory function in patients with epilepsy, respiratory function test results are lower than expected. Table 1 lists selected studies from the literature.

Despite significant progress in elucidating various aspects of epilepsy, the management of the disease still entails substantial risks and continues to pose numerous clinical challenges. It is well established that epileptic seizures can lead to a wide range of secondary complications, some of which are well recognized, while others remain underexplored. Among these, respiratory complications are particularly critical, including sleep apnea, impaired respiratory control, and associated cognitive and behavioral disturbances.

Given the severity and frequency of respiratory dysfunctions in individuals with epilepsy, it is imperative to raise awareness among clinicians and researchers of the importance of a multidisciplinary approach to the diagnosis and management of epilepsy. In this context, physiotherapy-based interventions should not only be seen as supportive but also as preventive components of treatment, with the potential to complement pharmacological and surgical approaches.

Integrating physiotherapy into epilepsy care may indirectly contribute to seizure management by improving respiratory function, sleep quality, physical conditioning, and overall quality of life, thereby supporting pharmacological and surgical treatment approaches. Therefore, future research and clinical practice should prioritize collaborative care models that include neurologists,

Table 1. Results regarding epilepsy and respiratory evaluations

Study	Sample size	Evaluation and assessment	Main results
Gökçek et al. (2021)[32]	30 individual aged 18-40 years with generalized epilepsy	Demographic data number of seizures per week, dyspnea with modified Medical Research Council, pulmonary function, level of physical activity with international physical assessment survey	Respiratory function and physical activity were affected
Pavlova et al. (2013)[33]	43 adult patients aged 22-62 years with seizure like non-epileptic events (SLNE)	Pulse oxymetry, electrocardiography and respiratory inductance plethysmography	Cardiorespiratory dysfunction, specifically bradypnea apnea, preictal bradycardia and oxygen saturation is more frequently seen in SLNE
Brotherstone et al. (2020)[34]	119 participants (65 children and 54 adults) with an age range of 0.66-62.1 years	Heart rate change and oxygen saturation were analysed from electroencephalography videotelemetry	Indicate that the novel algorithm can detect clinically significant seizures
Berilgen et al. (2004)[35]	A total of 32 epileptic patients (23 generalized, 9 partial epilepsy) and 32 healthy volunteers	Sympathetic skin response, for evaluating the sympathetic nervous system, respiratory function tests (RFTs)	No abnormalities were observed on RFTs in patients with either partial or generalized epilepsy

physiotherapists, pulmonologists, and other allied health professionals to optimize the overall management of epilepsy.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Ö.G., Concept: Ö.G., B.S., P.K., Design: Ö.G., B.S., P.K., Data Collection or Processing: Ö.G., B.S., P.K., Analysis or Interpretation: Ö.G., Literature Search: Ö.G., M.B., P.K., Writing: Ö.G., M.B., B.S., P.K., G.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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