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PHYSICAL ACTIVITY IN EPILEPSY

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ABSTRACT

Background: Epilepsy affects approximately 50 million individuals worldwide and represents a major contributor to global neurological morbidity. Despite increasing evidence supporting the safety and benefits of exercise, physical activity remains underutilized in this population. Individuals with epilepsy are consistently less active than the general population, largely due to persistent safety concerns and limited clinical guidance.
Aim: This narrative review aims to examine the relationship between epilepsy and physical activity, including epidemiology, underlying physiological mechanisms, potential benefits, associated risks, and clinical recommendations.
Materials and methods: A structured literature search was conducted using PubMed, Scopus, Web of Science, and Google Scholar, including studies published between 2008 and 2025. Eligible sources included original research articles, systematic reviews, and clinical guidelines addressing physical activity in individuals with epilepsy.
Results: The available evidence indicates that moderate-intensity physical activity does not increase seizure frequency in most patients and may, in some cases, contribute to seizure reduction. Proposed mechanisms include upregulation of brain-derived neurotrophic factor (BDNF), reduction of neuroinflammation, and improved autonomic regulation. Exercise is also associated with improvements in quality of life, mood, and physical fitness, which are often inadequately addressed by pharmacological treatment alone. The International League Against Epilepsy (ILAE) classification of sports according to seizure-related risk provides a practical framework for individualized recommendations.
Conclusions: Current evidence supports the incorporation of physical activity into epilepsy management, provided that recommendations are tailored to the individual patient.

KEYWORDS

Epilepsy, Physical Activity, Exercise, Seizures, Quality of Life, Sport Safety

CITATION

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1. Introduction

Epilepsy is a chronic neurological disorder characterised by a predisposition to recurrent, unprovoked seizures and is associated with significant cognitive, psychological, and social consequences. It is among the most prevalent neurological conditions worldwide and represents a substantial contributor to global disease burden (Stafstrom & Carmant, 2015).

Although seizure control remains the primary therapeutic objective, epilepsy care extends beyond pharmacological management. Individuals with epilepsy frequently experience psychiatric and psychosocial comorbidities, including depression, anxiety, and impaired quality of life, underscoring the need for integrated, multidisciplinary approaches (Capovilla et al., 2016).

Physical activity is a well-established determinant of physical and mental health in the general population. However, individuals with epilepsy are consistently less physically active than their peers without the condition. This disparity is largely driven by concerns regarding seizure provocation during exercise, perceived risk of injury, and inconsistent or overly cautious clinical counselling (Duñabeitia et al., 2022; *Epilepsy*, n.d.).

Recent evidence challenges these concerns, suggesting that, for most individuals with epilepsy, appropriately selected and supervised physical activity is safe and may confer meaningful health benefits. Despite this, low activity levels persist, indicating that barriers to participation remain multifactorial and insufficiently addressed in routine care (Duñabeitia et al., 2022; *Epilepsy*, n.d.).

Against this background, there is a need to consolidate current knowledge on the role of physical activity in epilepsy management. This narrative review synthesises evidence published between 2008 and 2025, focusing on the epidemiological context, clinical relevance, and practical considerations of physical activity in individuals with epilepsy.

2. Research materials and methods

This study was conducted as a narrative review of the literature focusing on the role of physical activity in patients with epilepsy, including their benefits, risks, and practical implications for management. The literature search was carried out using the following scientific databases:

PubMed, Scopus, Web of Science and Google Scholar. Articles published from 2008 to 2025 were considered for inclusion.

The search strategy included combinations of the following keywords: *epilepsy*, *physical activity*, *exercise*, *sport*, *seizures*, *exercise training* and *exercise in epilepsy*.

The inclusion criteria comprised original research articles, review papers, and clinical guidelines addressing physical activity or exercise in individuals with epilepsy.

Studies unrelated to the topic, articles not available in English and case reports without broader clinical relevance were excluded.

The identified publications were analysed narratively and grouped according to thematic categories relevant to the objectives of this review.

3. Epidemiology of Epilepsy and Physical Activity

3.1 Global burden of epilepsy

Epilepsy ranks among the most prevalent neurological disorders worldwide, affecting approximately 50 million individuals globally. Active epilepsy - defined as continuing seizures or an ongoing requirement for treatment - is estimated to affect between 4 and 10 per 1,000 persons in the general population at any given time. Approximately 5 million new cases are diagnosed annually, though incidence varies markedly by setting: rates in low- and middle-income countries reach up to 139 per 100,000 per year, compared with approximately 49 per 100,000 in high-income countries (*Epilepsy*, n.d.). This disparity is attributable in part to a greater burden of endemic neurological infections, birth-related injuries, and substantially reduced access to preventive care in resource-limited settings.

Lifetime prevalence is estimated at 7.6 per 1,000 persons, and epilepsy is associated with a range of comorbidities extending beyond seizure burden itself, including cognitive impairment, psychiatric morbidity, and social disadvantage (Van Den Bongard et al., 2020). Mortality risk in people with epilepsy is up to three times that of the general population, highlighting the clinical importance of identifying and addressing modifiable risk factors (*Epilepsy*, n.d.). Among these, physical inactivity is increasingly recognised as one of the most consequential.

3.2 Physical activity levels in people with epilepsy

Converging evidence indicates that people with epilepsy are substantially less physically active than the general population. A meta-analysis by Vancampfort et al. (2019), drawing on data from over 130,000 individuals across multiple countries, demonstrated that adults with epilepsy were significantly less likely to meet recommended physical activity guidelines (OR = 0.68; 95% CI = 0.53–0.87) and 1.57 times more likely to be classified as physically inactive relative to controls (OR = 1.57; 95% CI = 1.34–1.84) (Vancampfort et al., 2019). The breadth of the evidence base suggests that physical inactivity represents a population-level concern in epilepsy rather than an incidental clinical finding.

These findings are corroborated by a systematic review of 46 studies by Johnson et al. (2020), which found that in the majority of case-control analyses employing exercise and fitness testing, people with epilepsy performed significantly worse than healthy controls. Crucially, higher physical activity levels were consistently associated with better health-related quality of life and lower rates of depression and anxiety across included studies (Johnson et al., 2020). A contemporaneous systematic review by Van den Bogaart et al. (2020), encompassing 42 studies, similarly concluded that people with epilepsy are less physically active and less physically fit than the general population, with reduced activity associated with greater comorbidity burden and lower quality of life (Van Den Bongard et al., 2020).

The determinants of this activity deficit are multifactorial. A systematic review of physical activity correlates in people with epilepsy identified depression as the most consistently reported barrier in adults, followed by trait anxiety, medication side effects, and perceived stigma (Vancampfort & Ward, 2021). Additional barriers include fear of seizure provocation during exercise, concern regarding injury risk in the event of an ictal episode, limited availability of adapted programmes, and overly restrictive guidance from clinicians (Alexander et al., 2023). Notably, despite lower activity levels and reduced likelihood of meeting physical activity guidelines, the majority of people with epilepsy report a belief that physical activity would benefit their condition and express willingness to engage in exercise interventions; logistical factors, particularly transport and access to supervised sessions, appear to represent the principal obstacles to participation (Alexander et al., 2023).

3.3 Physical inactivity and health outcomes

The health consequences of sedentary behaviour in epilepsy are not limited to physical deconditioning. Cross-sectional evidence consistently demonstrates associations between higher physical activity levels and improved cognitive performance, better emotional well-being, and superior health-related quality of life in people with epilepsy (Häfele et al., 2017). Some analyses have additionally reported higher seizure frequencies among more sedentary individuals, though the directionality of this relationship cannot be established from cross-sectional data alone.

A large-scale analysis utilising accelerometer data from over 98,000 UK Biobank participants - including more than 1,100 individuals with epilepsy - found that people with epilepsy exhibited significantly elevated all-cause mortality (standardised mortality ratio 2.39), and that the association between physical activity and mortality in this population followed a pattern distinct from that observed in the general population (Fan et al., 2025). These findings argue for the development of epilepsy-specific physical activity guidance, rather than direct extrapolation from general population recommendations.

Of clinical relevance, analyses of national health survey data indicate that individuals with inactive epilepsy - defined as seizure-free and not currently receiving antiepileptic medication - demonstrate physical activity behaviours comparable to those of the general population (Churchill et al., 2024). This suggests that seizure control is a primary determinant of activity levels and that remission may substantially normalise participation. The implication for clinical practice is clear: as seizure control is achieved, actively encouraging return to physical activity should form an explicit component of ongoing patient management.

4. Pathophysiology of Epilepsy and Role of Physical Activity

Epilepsy is a chronic neurological disorder characterised by a persistent predisposition of the brain to generate epileptic seizures and by associated neurobiological, cognitive, psychological, and social consequences. According to the definition proposed by the International League Against Epilepsy (ILAE) in 2014, epilepsy can be diagnosed when any of the following conditions are met:

1) at least two unprovoked seizures occurring more than 24 hours apart,

2) one unprovoked seizure with a high probability of further seizures (at least 60% over the next 10 years),

or

3) the diagnosis of epilepsy syndrome (Fisher RS et al., 2014).

This definition reflects the current understanding of epilepsy as a disorder of brain networks rather than a single disease entity.

Further developments in epilepsy classification were introduced by the ILAE in 2017, which emphasized the importance of seizure onset in the diagnosis and classification of epileptic disorders. Seizures are currently categorised based on their onset as focal, generalized, or of unknown onset. In some cases, when the available information is insufficient, seizures may remain unclassified (Fisher et al., 2017).

From a pathophysiological perspective, epileptic seizures result from abnormal, excessive, and synchronous neuronal activity in the brain. A key mechanism underlying seizure generation is a disturbed balance between excitation and inhibition within neuronal networks. This imbalance may arise at multiple levels of brain function, ranging from genetic and molecular abnormalities to receptor dysfunction, altered ionic channel activity, and structural disturbances within neuronal circuits. Both inherited and acquired factors may contribute to these changes, leading to neuronal hyperexcitability and a greater tendency to generate epileptic discharges. The developing brain is particularly susceptible to seizures because excitatory synaptic mechanisms mature earlier than inhibitory ones. In addition, during early brain development, gamma-aminobutyric acid (GABA), which normally acts as an inhibitory neurotransmitter, may exert excitatory rather than inhibitory effects. These mechanisms partly explain the increased vulnerability to seizures observed early in life (Stafstrom & Carmant, 2015).

In addition to neurotransmitter imbalance and ion channel dysfunction, increasing attention has been paid to the role of neuroinflammation and oxidative stress in the development and progression of epilepsy. Pro-inflammatory cytokines and other inflammatory mediators may modify neuronal signalling and synaptic transmission, contributing to increased neuronal excitability and lowering the seizure threshold (Vezzani et al., 2011). Oxidative stress may further damage neuronal structures and disrupt mitochondrial function, which may promote epileptogenic processes within neural circuits (Waldbaum & Patel, 2010).

Physical activity may interact with several of these biological mechanisms. Historically, individuals with epilepsy were discouraged from participating in sports because of concerns about seizure provocation and the risk of injury. However, current evidence suggests that appropriately selected physical activity is generally safe for most people with epilepsy and may provide both health and psychosocial benefits (Capovilla et al., 2016). Regular exercise has been associated with several neurobiological adaptations that may influence the pathophysiology of epilepsy. Experimental studies suggest that physical activity may reduce seizure susceptibility and induce adaptive neurobiological changes relevant to epilepsy (Arida et al., 2008; Cavalcante et al., 2021). In addition, exercise may promote physiological adaptations that support overall brain homeostasis and neuronal stability. It has also been proposed that physical activity can influence autonomic regulation and stress- related mechanisms, which may be important in the context of seizure occurrence (Arida, 2021; Arida et al., 2008). Furthermore, regular physical activity may promote adaptive neurobiological changes in the epileptic brain, such as increased BDNF expression, enhanced neurogenesis, reduced oxidative stress and reactive gliosis, and modulation of dopaminergic activity (Cavalcante et al., 2021).

Physical activity may also indirectly affect the course of epilepsy by improving psychosocial and systemic health. Individuals with epilepsy frequently experience comorbid conditions such as depression, anxiety, sleep disturbances, and reduced physical fitness. Exercise interventions have been shown to improve mood, reduce anxiety levels, enhance sleep quality, and increase overall quality of life in individuals with epilepsy. Recent systematic reviews and meta-analyses indicate that structured physical activity programs may significantly improve psychosocial functioning and overall well-being in people with epilepsy. These factors may indirectly support better disease management and may be associated with more favourable seizure outcomes (Capovilla et al., 2016; Cavalcante et al., 2021; Duñabeitia et al., 2022).

Despite these potential benefits, certain forms of intense physical exertion may occasionally provoke seizures in susceptible individuals. Factors such as hyperventilation, dehydration, sleep deprivation, hypoglycaemia, metabolic stress, and overheating during prolonged or high-intensity exercise may increase seizure risk. Nevertheless, current evidence suggests that moderate and supervised physical activity carries relatively low risk and may provide substantial health benefits for most individuals with epilepsy (Arida, 2021; Capovilla et al., 2016). Overall, the relationship between epilepsy and physical activity appears to be complex and bidirectional. While the pathophysiological mechanisms of epilepsy may influence exercise tolerance and safety, regular physical activity may positively modify several biological and psychosocial factors associated with the disease. Consequently, modern clinical recommendations increasingly support appropriately tailored physical activity as part of comprehensive epilepsy management strategies (Arida, 2021; Arida et al., 2008; Capovilla et al., 2016; Cavalcante et al., 2021).

5. Classification of Sports According to Risk

Physical activity can be broadly categorised into aerobic exercise, anaerobic (high-intensity) exercise, resistance training, and mind–body exercise. Aerobic exercise comprises low- to moderate-intensity activities in which energy is generated primarily through oxidative metabolism. Typical examples include walking, running, swimming, and cycling. Exercise intensity is commonly defined relative to maximal heart rate (HRmax), with moderate intensity generally corresponding to approximately 50-70% of HRmax, although this threshold should be interpreted as a continuum rather than a strict cutoff. The World Health Organization recommends that adults engage in 150-300 minutes of moderate-intensity aerobic physical activity per week (Bull et al., 2020).

Anaerobic exercise refers to high-intensity activities in which energy is supplied primarily through anaerobic metabolic pathways, including glycolysis and phosphagen systems. These activities are typically performed at intensities exceeding approximately 70-85% of HRmax and include sprinting, high-intensity interval training (HIIT), and certain forms of resistance exercise. In practice, most sports involve a combination of aerobic and anaerobic energy systems rather than a purely aerobic or anaerobic.

Resistance (strength) training, when performed with appropriate technique and individualized load, improves muscular strength and has beneficial effects on bone density and overall musculoskeletal health. Current evidence indicates that properly prescribed resistance training is safe for individuals with epilepsy and does not appear to increase seizure frequency (Capovilla et al., 2016).

Mind–body exercises such as yoga and tai chi may contribute to stress reduction and improved psychological well-being, factors that are relevant in seizure susceptibility. Some studies suggest a potential beneficial effect on seizure control; however, the evidence remains limited and heterogeneous. Importantly, hyperventilation-particularly during breathing-focused practices- may act as a seizure-provoking factor in susceptible individuals and should therefore be avoided (Panebianco et al., 2017).

6. Physical Activity in Patients with Epilepsy

Long-term analyses conducted by Professor Ricardo Mario Arida's team demonstrate that over the past twenty years, the percentage of people with epilepsy regularly engaging in physical exercise has nearly quadrupled, now reaching approximately 60% (Arida et al., 2025). These findings align with ILAE recommendations, proving that when appropriate precautions are taken, the risk of a seizure during exercise remains marginal and affects only a small minority of patients (Arida et al., 2025). Available data indicate that engaging in moderate physical activity not only optimizes cognitive processes and alleviates anxiety and depressive symptoms in individuals with epilepsy, but also translates into a higher quality of daily life and greater patient autonomy (Fan et al., 2025). Such positive outcomes suggest that continued collaboration between patients and their healthcare teams, along with a shared focus on safety awareness, can effectively encourage more individuals to experience the extensive benefits of an active lifestyle.

7. Risk of Seizures during Exercise

Contrary to past concerns, physical exercise does not exacerbate seizures; rather, it actively reduces seizure susceptibility, serving as a valuable adjunct to conventional pharmacological treatment (Fan et al., 2025). This phenomenon is explained by the capacity of physical activity to attenuate neuroinflammation and modulate the hypothalamic-pituitary-adrenal axis, thereby significantly lowering stress levels-one of the primary seizure triggers (Capovilla et al., 2016). Furthermore, sports stimulate the production of neurotrophic factors and balance neurotransmitter levels, which directly stabilizes the brain's electrical activity. Incorporating exercise into a patient's routine not only raises the seizure threshold but also fosters socialization and enhances the overall quality of life in this chronic illness (Pinho et al., 2024).

8. Safety Considerations in Sport

Safety in sports for individuals with epilepsy depends on a personalized risk assessment of seizure types and the specific discipline (Capovilla et al., 2016). While high-risk sports like diving are discouraged and cycling requires stable control, specific triggers can be managed through activity-based EEGs and adjusted supervision. Furthermore, high-performance athletes must disclose their medication to ensure anti-doping compliance (Capovilla et al., 2016). This highlights the necessity of a transparent and multidisciplinary dialogue between the athlete, the coach, and the neurologist to minimize risks.

9. Types of Physical Activity in Epilepsy

The classification of sports disciplines adopted by the ILAE (International League Against Epilepsy) for patients with epilepsy is based on a three-tier scale assessing the risk to health and life in the event of a seizure (Capovilla et al., 2016). The first category includes activities with minimal additional risk. The second consists of sports posing a moderate risk to the patient (while presenting no risk to bystanders), whereas the third group comprises disciplines with the highest degree of danger. When assessing a patient's eligibility for a specific sport, the clinician should analyse not only the type and frequency of seizures or their triggers, but also the individual timing of their occurrence and the patient's subjective readiness to accept risk (Capovilla et al., 2016).

Based on these safety parameters, the ILAE guidelines categorise specific physical activities into the following three groups:

- Group 1 (Minimal additional risk to the participant and bystanders):

This category encompasses activities that do not expose the patient or the public to any notable extra danger. It includes track and field, most team games (such as soccer, basketball, volleyball, and baseball), racket disciplines (tennis, squash), as well as dancing and bowling (Cartagena et al., 2020).

- Group 2 (Moderate risk to the participant, no danger to others):

Individuals with epilepsy can engage in these sports, although it is highly recommended to do so under appropriate supervision and following medical clearance. Common examples comprise swimming, bicycling, downhill skiing, gymnastics, grappling-based martial arts (e.g., judo), and weightlifting (Cartagena et al., 2020).

- Group 3 (Substantial risk to the patient, and potentially to the public):

Participation in these extreme disciplines is generally advised against, unless the individual has remained completely seizure-free over an extended period. This includes activities like scuba diving, rock climbing, aerial sports (such as parachuting or hang gliding), motorsports, and ski jumping (Cartagena et al., 2020).

10. Guidelines and Recommendations for Physical Activity in Patients with Epilepsy

Most patients with epilepsy should be encouraged to engage in regular physical activity in accordance with general population guidelines provided by the World Health Organization (Bull et al., 2020), as these recommendations are considered applicable to the majority of individuals with epilepsy. Current evidence indicates that physical activity improves quality of life, reduces stress - one of the recognized seizure triggers - and may contribute to better seizure control in some patients (Arida et al., 2025; Capovilla et al., 2016).

However, exercise recommendations should be individualized, particularly in patients with uncontrolled or poorly controlled seizures, in line with guidance from the International League Against Epilepsy. This includes consideration of sport-specific risk stratification (low-, moderate-, and high-risk activities), as well as patient- related factors such as belonging to a special population, history of seizure-related injuries, and the presence of comorbidities (Fisher et al., 2017).

11. Special Populations

Although physical activity is considered safe for most individuals with epilepsy and may provide additional health benefits, special attention should be given to specific patient populations. Individuals with epilepsy can follow the World Health Organization (WHO) recommendations for physical activity for the general population, with appropriate individual modifications for children and adolescents, older adults, and pregnant women (Bull et al., 2020).

In children and adolescents, current evidence suggests that physical activity does not increase seizure risk and may even exert a protective effect. Moreover, regular exercise has been associated with improved quality of life and psychosocial functioning (Arida & Teixeira-Machado, 2023; Zhang et al., 2019). However, it should be emphasized that the available evidence is largely based on observational studies, and interventional trials remain limited.

In older adults with epilepsy, additional factors such as frailty, increased risk of falls, dizziness, comorbidities, and reduced bone mineral density should be considered when recommending exercise. Low-impact aerobics activities, including walking and stationary cycling, as well as resistance training, are generally recommended (Arida et al., 2008). Nevertheless, evidence from interventional studies in this population is scarce.

Pregnant women with epilepsy can also engage in physical activity; however, exercise programs should be individualized based on seizure frequency, antiepileptic treatment, and the course of pregnancy. Activities associated with a high risk of trauma or falls should be avoided. Due to the lack of epilepsy-specific research in this group, recommendations are primarily extrapolated from general guidelines for physical activity during pregnancy (Bull et al., 2020).

12. Limitations and future directions

This narrative review has several limitations that should be acknowledged. First, the review is based on a narrative rather than a systematic methodology, which increases the risk of selection bias and limits the reproducibility of the search process.

Second, the available evidence on physical activity in epilepsy remains heterogeneous. The included studies differ substantially in terms of study design, patient populations, epilepsy types, seizure severity, and the type, duration, and intensity of exercise interventions. This heterogeneity makes direct comparisons difficult and limits the generalizability of the findings.

Another limitation concerns the underrepresentation of specific subgroups, such as children, older adults, pregnant women, and patients with drug-resistant epilepsy. These populations may have distinct needs and risks related to physical activity, and current recommendations are often extrapolated from studies conducted in the general epilepsy population.

Future research should focus on large-scale prospective studies and randomized controlled trials to establish evidence-based exercise protocols tailored to different epilepsy syndromes and patient characteristics. Further investigation into the neurobiological mechanisms underlying the effects of physical activity on seizure susceptibility, including the role of neuroinflammation, oxidative stress, and neurotrophic factors, is also needed. In addition, future studies should aim to develop practical, individualized guidelines that can be implemented in routine clinical care to improve both seizure management and overall quality of life in people with epilepsy.

13. Conclusions

Physical activity should no longer be viewed as a contraindication in epilepsy, but rather as an important component of comprehensive disease management. Current evidence indicates that regular, appropriately selected exercise is safe for most individuals with epilepsy and may provide substantial physical, psychological, and quality-of-life benefits. In addition to its potential role in reducing seizure susceptibility through mechanisms such as modulation of neuroinflammation, oxidative stress, and neurotrophic regulation, physical activity contributes to improved mental well-being, physical fitness, and social functioning. Despite these benefits, people with epilepsy remain less physically active than the general population due to persistent misconceptions, fear of seizure provocation, and insufficient clinical guidance. Greater emphasis should be placed on individualized exercise counselling in routine clinical care, taking into account seizure control, epilepsy type, comorbidities, and sport-specific risks. Further prospective and interventional studies are needed to establish epilepsy-specific exercise recommendations and to clarify the long-term impact of physical activity on seizure control and overall disease outcomes.

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Author Contributions:

Conceptualization, S.J., J.S. and T.W.; methodology, J.S.; formal analysis, J.S. and M.Ś.; investigation, T.W., A.N.O., and M.Ś.; resources, T.W., A.N.O., and M.Ś.; data curation, T.W., A.N.O., and M.Ś.; writing-original draft preparation, T.W., A.N.O., M.Ś. and S.J.; writing-review and editing, S.J. and J.S.; supervision, S.J., J.S., and M.Ś.; project administration, S.J. All authors have read and agreed to the published version of the manuscript

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