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Review The potential role of physical exercise in the treatment of epilepsy

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1. Introduction

Nonpharmacological therapies, including complementary and alternative medicine (CAM), are often used by patients with epilepsy, frequently without the knowledge of their physicians [1-8]. Exercise is infrequently cited as a complementary therapy, yet the beneficial effects of exercise have been increasingly reported for persons with epilepsy, both for seizure control and for improvement of quality of life.

2. Exercise and effects on seizures and the EEG

Persons with epilepsy are often cautioned to avoid vigorous exercise to prevent seizures. Although there are rare cases of exercise-induced seizures, studies have generally shown that physical activity can decrease seizure frequency, as well as lead to improved cardiovascular and psychological health in people with epilepsy [9–13]. Interictal epileptiform activity recorded by electroencephalograms (EEGs) remains unchanged or decreases in frequency during or immediately after exercise in the majority of patients studied, even in some patients with exercise-associated seizures [11,14–16]. Fewer seizures occur during both mental and physical activity compared with periods of rest [17], suggesting that increased attention and

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ABSTRACT

The beneficial effects of exercise for people with epilepsy, including reduction of seizure susceptibility, improvement of quality of life, reduction of anxiety and depression, and better social integration, have increasingly been reported. We present data from human and animal studies supporting the role of exercise as a therapy for epilepsy complementary to standard treatments.

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vigilance during physical activity may reduce the occurrence of seizures [15]. Accordingly, some investigators have suggested that exercise may have an anticonvulsant effect on persons with epilepsy [14,18]. One supportive hypothesis proposes that ß-endorphins released during exercise inhibit epileptic discharges [19].

Although only a few studies have evaluated supervised exercise programs for patients with epilepsy; the findings are promising. For instance, Nakken and co-workers [10] reported that 4 weeks of an aerobic training program did not change average seizure frequency. A study in women with medically refractory epilepsy demonstrated that aerobic physical training decreased the number of seizures during the exercise period [12]. Another study showed no impact on seizure frequency after a 12-week exercise program [20].

Epidemiological studies add supportive evidence. A study comparing the exercise habits of people with epilepsy versus controls found that more than half of the patients never had a seizure during exercise, and only 2% of them had exercise-induced seizures (defined as seizures in >50% of the training sessions) [21]. Additionally, Korczyn [22] reported that only 5 of 250 individuals with epilepsy aged 10 years and older experienced a seizure while participating in sport activities. Ninety patients denied ever having a seizure during physical exercise. Seizures during exercise occurred in 6 of 21 patients in the study of Bjorholt et al. [23] and none of the patients in another study [24].

Several animal studies have shown the beneficial effects of exercise on seizure expression [for reviews, see 13,15]. Using the pilocarpine model, investigators demonstrated a significant reduction in seizure frequency during an aerobic training period



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when compared with controls over 135 days of monitoring [26]. In another study, physical training before and during amygdala kindling retarded the development of spontaneous seizures [27]. Metabolic, electrophysiological, and immunohistochemical studies have also found positive effects of exercise in rat models of epilepsy [28–30].

3. Caution in sports participation

In the past, people with epilepsy had been cautioned with respect to different sports or physical activities [31–35]. It is conceivable that seizures might be injurious during certain sports activities, and people with epilepsy who have more frequent or uncontrolled seizures should be more cautious when choosing sports. The person with epilepsy deciding to participate in sports must determine whether the benefit outweighs the risk. The risk/ benefit ratio for a person with epilepsy is dependent on the sports activity considered, the type of seizure that might occur, as well as the probability that a seizure will occur during the activity. Some sports activities and their restrictions with respect to people with epilepsy can be found elsewhere [36].

Although merely speculative, some factors in exercise programs, such as fatigue, the stress of competition [17], hypoxia, hyperthermia, and hypoglycemia, may affect the epileptic disorder [37]. Seizures are most likely to occur after exercise (minutes to hours). For instance, in two retrospective reports [11,38], 23 and 65% of children with epilepsy had an increase in epileptiform discharges on EEGs immediately after exercise when compared with baseline. However, the mechanisms responsible for this occurrence are unclear. Hyperventilation is used during EEG recording to increase epileptiform

activity. Paradoxically, compensatory hyperventilation during exercise improves the EEG. Increased ventilation during physical training is a compensatory homeostatic mechanism; the respiratory alkalosis of induced hyperventilation does not occur [39]. EEG studies have shown that epileptiform activity is often reduced during physical exertion and in only a small proportion of patients is an increase in interictal discharges observed during or after exercise [11].

4. Benefits of exercise on psychiatric comorbidities

People with epilepsy frequently experience psychiatric comorbidities, most commonly depressive and anxiety disorders [40]. Furthermore, stress is among the most frequently self-reported precipitants of seizures [40-43]. Therefore, the effects of exercise on mood disorders and stress are of interest. In the general population, regular exercise has been shown to provide mood benefits [44], aid in the treatment of depression [45], and attenuate the impact of stressful life events [46]. Studies in persons with epilepsy suggest that they derive similar psychological benefits from physical activity. For instance, Roth et al. [47] examined physical exercise, stressful life experiences, and depression in adults with epilepsy and found that active subjects had significantly lower levels of depression than inactive subjects, as well as better psychosocial adjustment. Similarly, Nakken et al. [10] noted that after a 4-week exercise program, patients with epilepsy had an improved mental state and became more sociable. A study in women with medically refractory epilepsy found that a regular exercise program improved psychosocial functioning and quality of life [12]. McAuley and colleagues [20] noted an improvement in mood in patients with epilepsy who exercised for 12 weeks as



Fig. 1. Comparison of the effects of complementary and alternative medicine (CAM) and physical exercise on both seizure and nonseizure conditions. Available data suggest that adequate physical exercise can provide most of the putative positive benefits of CAM modalities without their potential adverse effects.

compared with those who did not exercise. Other research suggests that prohibiting patients from participating in sports can result in emotional distress [18,48].

5. General health benefits of exercise in patients with epilepsy

Regular physical activity is generally accepted as a means of promoting general health and well-being [37] and improving cardiovascular fitness [49–51]. Therefore, people with epilepsy may receive similar benefits from physical activity, such as increased maximal aerobic capacity, increased work capacity, reduced heart rate on submaximal standardized work level, and weight reduction with reduced body fat [9,10,25,52,53]. Exercise has also been shown to have positive effects on bone density [54]. It is well documented that use of antiepileptic drugs (AEDs) leads to bone loss [55], and studies have demonstrated that bone loss can occur after as little as 2 years of AED exposure [56]. In this regard, exercise should be recommended to patients with epilepsy as an osteoprotective behavior.

6. Conclusion

Data from animal and human neurophysiological studies, controlled trials, and epidemiological surveys suggest a role for exercise as an adjunctive form of therapy for epilepsy and as a tool for the promotion of health and wellness in this population (Fig. 1). Therefore, neurologists should consider the possible general health and specific epilepsy-related benefits of regular physical exercise for their patients. Further research is needed so that patients who are at greatest risk for exercise-induced seizures may be identified prospectively.

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