

Participation in Sports Activities in People with Epilepsy

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Abstract

Sports activities are of physiological, social, and psychological importance for people with epilepsy as well as for every other person. However, participation in sports activities is less common in people with epilepsy. Patients usually tend to refrain from participating in sports activities for several reasons such as the risk of injuries, the risk of physical exercise inducing seizures, stigmatization, prejudice, or lack of efficient medical advice. In this review, we specified the sports branches with their possible risks, precautions to be taken and their related advice for people with epilepsy. The sports branches are examined in the headings as martial arts, outdoor sports, collective ground sports, and gymnastics. The possible risk of injury, risk of the particular sports branch to precipitate a seizure, and the necessary precautions in each sports branch are discussed separately. A detailed clinical evaluation is required to make an appropriate decision on whether an individual with epilepsy can practice the mentioned sport. The type of sport, the type and frequency of seizures, presence of aura, seizure triggers, drug compliance, presence of efficient supervision, and presence of protective equipment should be evaluated. In this review, we have evaluated these topics for each sports branch separately. When appropriate precautions are taken in patients with epilepsy, sports will be accepted as a therapeutic entity rather than a ban.

Keywords: Collective ground sports, epilepsy, gymnastic, martial arts, outdoor sports, physical exercise, and sports

INTRODUCTION

People with epilepsy (PWE) are generally physically less active, and participation in sports activities is less common.¹⁻³ Participation in sports activities is less than 25% in PWE.⁴ Although the beneficial effects of sports in PWE are known, patients tend to refrain from participating in sports activities for various reasons. Some of these are the fear of that sports activities might cause injuries, or potentially induce seizures, lack of knowledge about the favorable effects of sports, stigmatization, prejudice, and lack of efficient medical advice.^{1,2} Studies have shown that most avoided activities are joining a team or a group activity.⁵ There are various beneficial effects of regular physical exercise, such as improved quality of life, seizure control, mental and general health, increase in sleep quality, decrease in stress, decrease in cumulative physical and mental fatigue, increased socialization and self-esteem.^{1,2,6,7} Considering that most of the epilepsies are well controlled with medication; so that PWE should not be discouraged from participating in sports. Because individuals with epilepsy must deal with many social stigmas, preventing them from sports affects their quality of life even more negatively.

It is recommended that an individual should engage in at least 150 min of moderate-intensity (such as walking or cycling) or 75-minutes of vigorous-intensity (such as running) exercises per week. This situation is similar for individuals with epilepsy.

A reason for lesser participation of PWE in sports is the insufficient knowledge of health professionals on this subject.^{8,9} However, in recent years, attitudes have been changing for PWE in favor of doing sports.³ The ILAE task force on Sports and Epilepsy released a report in 2015, which aims to guide individuals with epilepsy about sports participation. According to this guideline, sports are divided into 3 groups according to their potential risks for injury for PWE. Group 1 sports contain no additional risk for the patient (examples: athletics, bowling, judo, wrestling, skiing, dancing, racquet sports, collective contact sports such as baseball, football, basketball, volleyball), and Group 2 sports have moderate risk for PWE, but not risky for bystanders (examples: archery, triathlon, canoeing, boxing, karate, cycling, fencing, gymnastic, horse riding, skateing, swimming, snowboarding), and Group 3 sports are the ones with major risk of injury/death for PWE and bystanders (aviation, climbing, diving, horse racing, motor sports, parachuting, scuba diving, ski jumping, surfing). However, they have stated that still some sports fall in a gray zone, and a different categorization may be performed in an individual basis.⁶

To improve the biological and psychosocial health of individuals with epilepsy, the most appropriate sports-branch should be selected, necessary education should be provided, and under competent supervision, patients should be encouraged to exercise confidently. A detailed clinical evaluation is required to make an appropriate decision on whether an individual with epilepsy can practice the mentioned sport.

The type of sport, the type and frequency of seizures, presence of aura, seizure triggers, drug compliance, and presence of efficient supervision, and presence of protective equipment should be evaluated (Table 1).

In this review, we specified the sports branches with their possible risks, precautions to be taken and their related advice for PWE.

Sports Branches

1. Martial Arts/Combat Sports

Martial arts can be divided into those with a high risk of injury and those without. However, martial arts in general have favorable effects on mental calmness and self-esteem, which may have a positive influence on epilepsy. Because martial arts are performed indoors and are under uninterrupted supervision, it allows the athlete to be intervened quickly if necessary.

1.1 Boxing

Among the martial arts, boxing seems to be the most risky one for injury and therefore the one with no consensus on it.³ It is classified in Group 2 by the ILAE report.⁶ Head blows are very common in boxing compared to other martial arts. The concern is whether head injury can trigger seizures. Even the association of minor head trauma with seizures is not prominent, the kicks of boxing may be harder and repetitive than other sports. There are animal models showing that repetitive concussions cause progressive

Table 1. Factors affecting decisions of people with epilepsy doing sports

Seizure type
Seizure frequency
Timing of seizures
Duration of epilepsy diagnosis
Presence of aura
Presence of mental retardation
Presence of efficient supervision
Drug compliance
Seizure triggers
Patient preferences/risk tolerance
The risk potential of the particular sports branch

MAIN POINTS

- Sports activities are of physiological, social, and psychological importance for people with epilepsy (PWE) just as for every other person.
- With respect to guidelines of ILAE emerged at this decade, attitudes started to change in favor of encouraging PWE to practise sports even more.
- For clinicians to guide their patients, the decision should solely be tailored patient-based; taking into account of the type and frequency of seizures, presence of aura, seizure triggers and drug compliance.
- As long as the appropriate sports-branch is selected, sport specific recommendations are applied, necessary education is given and competent supervision with efficient protective equipment is provided, patients can carry out the exercise confidently.

phenotypical changes characterized by an initial glutamate increase that is accompanied by glutathione consumption and followed by a dysfunction of parvalbumin-positive interneurons and loss of gamma-aminobutyric acid related inhibitory tone, which supports an increased risk of developing epilepsy.¹⁰ Therefore, there is a common tendency to limit participation to boxing in PWE. It may be evaluated patient based, and if performed, a helmet must be used.

1.2 Karate

Head and face blows should be in a light and controlled manner in karate. The athletes wear foot protectors and mitts, which further reduce the severity of the impact. In addition, head blows are not allowed in children under 14 years. This age group should wear a face mask and helmet also.¹¹ For children between 14-16 years, only skin touch is allowed for kicks, which means touching the target without transferring energy into the head or body. Therefore, it seems safe, especially in children. However, there are subtypes of karate such as 'full contact karate' and 'knockdown karate', which can cause injury. Therefore, if an individual with epilepsy prefers to do karate, he/she should avoid taking part in full-contact karate. Additionally, head protection equipment should be preferred.

1.3 Taekwondo

Taekwondo is performed with protective equipment on the head, trunk, and shin area. By the rules, the kick with the lower part of the ankle can be directed to the chest and head, but the punch can only be thrown to the chest area of the opponent. In professional matches, these protective equipments have sensors and measure opponents strike intensity. Even though head blows and concussions are frequent in taekwondo competitions¹², the use of electronical sensor systems recently has led to more controlled strike intensities. It can be considered safer for PWE compared to other martial arts where a direct punch to the head is allowed.

1.4 Judo

Judo is a branch of martial arts whose rules are determined in order not to cause an injury to the opponent, by its nature. Punches, kicks, other blows, and contact with the face are not allowed, and only throws and grappling are used to control the opponent. Fallings have special techniques that minimize blows to the head and neck.^{13,14} In this way, head blows are minimized, and if done professionally and correctly, it can be considered safe for individuals with epilepsy. Studies have shown that the most injured areas in judo and taekwondo are lower extremities.¹⁵

1.5 Fencing

Fencing is a type of martial art that uses a sword. It is based on the principle of scoring as many points as touched in certain areas of the opponent. Masks are worn on the face as a protective equipment. There are three types of fencing according to the sword type and technique: foil, epee, and sabre. The foil is just a thrusting weapon and the target is trunk, whereas in the sabre, the target is the entire body including the head. Therefore the foil technique may be more appropriate for PWE. It is suitable for individuals with epilepsy as it minimizes head traumas.

1.6 Wrestling

Wrestling is classified as a Group 1 activity according to the ILAE and does not pose any additional risk for PWE.⁶ Wrestling may be safe for children with well-controlled seizures or seizures that do not impair consciousness or motor control.¹⁶ Wearing headgear with a frontal pad can also minimize the impact of the forehead and help prevent concussions. Choking techniques in wrestling that make breathing difficult will lower the seizure threshold in these individuals secondary to central hypoxia. Although choking is illegal in professional wrestling, in some types of wrestling, choking can be used as a submission hold for the opponent, which poses a serious risk for PWE.

1.7 Aikido

Aikido is born from armed combat. It is performed without a helmet. It is based on the principle that an opponent initiates the attack within a certain pattern and the other must neutralize it. In this sport, blows from the front and the sides of the head and face pushing are allowed, which render the person in a risk for head blow. In particular, some techniques like shihonage and iriminage may cause the opponent to hit the back of their head to the floor.¹⁷ To minimize the risks, matches can be held without these techniques, if not, a softer and thicker aikido mat may be used and well training of neck muscles beforehand might prevent major injuries. The absence of a free attack practice ensures the next blow to be predictable, so that head protection techniques can be emphasized for an individual with epilepsy.

2. Outdoor Sports

2.1 Walking/Running

Walking and running are considered low-risk activities for PWE. Walking and running are appropriate exercise types which have beneficial effects on the neuropsychological profile and seizure outcomes of PWE.¹ However, running that requires prolonged aerobic capacity, such as marathon or triathlon run, can be risky as they may reveal metabolic disturbances leading to acute symptomatic seizures. The metabolic disturbance associated with prolonged running is hyponatremia. The main risk for hyponatremia is excessive fluid intake during and after the exercise, which may be seen in prolonged exercises such as marathon running and triathlon.⁸ In the study of Davis et al.¹⁸ including 26 healthy marathon runners who developed hyponatremia, three with severe hyponatremia ($\text{Na} < 125 \text{ mEq/L}$) developed seizures. The possibility that epileptic individuals being more susceptible to hyponatremia should be considered in this respect. Another physiologic condition during aerobic exercise is hyperventilation. While resting hyperventilation can trigger seizures by causing central hypocapnia and vasoconstriction; hyperventilation during aerobic exercise is a physiological compensation and has been shown not to cause seizure activity.³ Hypoglycemia may be another trigger for seizures. To avoid the hypoglycemic effect of prolonged aerobic activity, adequate nutrition should be provided before the exercise.⁸

It is recommended that PWE should be accompanied by another person during walking/running; adequate fluid consumption and

nutrition are provided before the exercise and they should avoid performing the activities on a treadmill because falling may lead to major injuries.^{16,19}

2.2 Mountaineering/Sportive Climbing

Mountaineering can be divided into two categories, the first one is an expeditive style, which is performed at high-altitudes. Another is sportive climbing, which is performed on the rocks or artificial climbing walls. In general, sports performed at heights should be avoided in PWE. Climbing is classified as Group 3 in the ILAE report. Mountaineering in an expeditive style is risky in two ways, firstly, hypoxia from high-altitude can increase the risk of seizures.⁸ Secondly seizure during climbing can be life-threatening for both the person and bystanders.⁶ Outdoor sportive climbing on the rocks does not involve the risk of hypoxia; however, the risk of severe injury for the patient and bystanders remains. However, it seems safe to climb as an indoor activity to a specifically designed wall for climbers under convenient observation and with a head gear.

Trekking and hiking are safe activities for PWE; however, an electronic localizer device would be beneficial.

2.3 Cycling

Since cycling involves high speeds, the risk of injury is high in case a seizure occurs. Individual risk assessment should be performed. It is not recommended for those with uncontrolled seizures. It can be performed with certain precautions in individuals with seizure control. A helmet must be worn. It is important to use protective pads (knee, elbow, wrist). It is not recommended to cycle in a busy location, on a sloping track and at high speeds.³ Individuals with epilepsy may prefer 3-wheel bicycles instead of 2-wheel bicycles. In the case of a person with seizures with impaired awareness, to protect the individual while cycling, unique equipment with a loosely adjusted harness and high back may be preferred produced by private companies (Figure 1).



Figure 1. Three wheel bike for people with epilepsy

2.4 Parachuting

Parachuting is considered a high-risk activity for PWE and is not recommended. Any seizure activity that may occur in high-altitude will result in a life-threatening condition. If the person with epilepsy wants to parachute, it is recommended to do a “tandem skydive” (with the group) and with another person in the group who is under surveillance of the situation of the individual. Preferably, these patients should have controlled seizures and seizures without loss of awareness.

2.5 Skiing

ILAE classified cross country skiing in Group 1 but ski jumping in Group 3 activity.⁶ Skiers should wear protective gears, especially a helmet. Additionally, sun glasses are important, especially for photosensitive epilepsies. Patients should not be alone in the ski lift. Skiing on high slopes and downhill skiing will pose a risk in the case of a seizure. It is recommended to use an electronic localizer device and have a person accompanying the patient.

2.6 Rafting/Canoeing

Rafting is safe for PWE while taking the safety measures. Wearing a life jacket during the activity, doing it in a group and with a professional, being in the middle rather than the front or back, and wearing an electronic localizer device will reduce the risks in case of any seizure development by providing a rapid first aid. The precautions for canoeing are similar to rafting. All individuals with photosensitive seizures are advised to wear sunglasses. In case of a seizure, the canoe may overturn, the person may get trapped under the canoe, and if awareness is lost, this situation will pose a life-threatening risk. It is recommended to wear lifejackets while performing water sports.^{16,19}

2.7 Horse Riding

The ILAE report has classified horse riding in the Group 2; however, horse racing in Group 3.⁶ Having a seizure during riding includes severe injury risk. Individual risk assessments should be considered. Horse riding may be permitted for patients with controlled epilepsy with caution. It is recommended that a riding hat is worn. Additionally, an equipment that connects the individual to the horse in order not to fall from height during the seizure is recommended. It should be practiced under close surveillance of a person who knows the condition of the patient.^{3,19}

2.8 Swimming

It has been shown that the risk of drowning is increased in PWE while swimming.²⁰ Patients need to be evaluated according to his/her clinical conditions. While it includes a high risk for individuals with frequent seizures and seizures with impaired awareness: those who are seizure-free for more than 1 year, those who have only nocturnal seizures, and those who do not lose awareness can practice under close supervision. The supervisor should be a trained professional for cardiopulmonary resuscitation.³ It is recommended to do it as a team, to wear a colored cap that indicates the individual's condition, and to do it in the pool instead of open waters. Individuals with photosensitive seizures caused by refraction of light should wear goggles. Patients should avoid

hyperventilating deep fast breaths, or holding breath for swimming underwater for a long time. Individuals with a high frequency of seizures should definitely wear a life jacket. Adequate nutrition should be provided to avoid hypoglycemia.^{16,19,21}

2.9 Scuba Diving

Scuba diving includes a high risk for PWE and should be avoided. Apart from scuba diving specific risks such as decompression sickness, oxygen toxicity, and nitrogen narcosis, which can lower the seizure threshold; this activity inherently poses a serious life-threatening risk because if a seizure occurs under the water, it might not be detected, and the rescuer might arrive late.^{3,6,22}

2.10 Motor Sports

Whether PWE can drive a motor vehicle or not varies according to the laws of the countries, yet, motor sports are categorized in the risky activity class. In the case of a seizure, the person will risk his life and the lives of the bystanders.⁶ Since the activity includes high excitement, this may be another stressing factor that may trigger seizures. The United Kingdom national karting association recommends individuals to be seizure free for 1 year before doing the activity.¹⁹ It is not recommended for people with uncontrolled epilepsy.

3. Collective Ground Sports

3.1 Football

Collective ground sports are generally thought to be safe. General considerations for aerobic sports such as avoiding dehydration, hypoglycemia, and overhydration, should be considered. However, it should be taken into consideration that heading is free in football, which may lead to minor head traumas. Concussion was not found to have significance for epilepsy development;²³ but frequent and severe blows should be avoided. It is recommended that teammates and the coach to be aware of the situation and know how to manage the seizure. There was no significant difference found between an individual with epilepsy and a healthy individual to have a seizure while playing football.²⁴

3.2 Basketball

It is a safe activity for individuals when the team and coach are aware of the situation, know how to manage the seizure, avoid symptomatic seizure triggers and make the individual with epilepsy rest more frequently than other team players. Attention should be paid to head blows caused by contact sports, and a protective concussion headband or helmet may be worn.

3.3 Volleyball

Although it is considered a contact sport, it differs from other team sports in that it is not in one-on-one struggle with the opposing team player, and the head blow is minimal. It is in the low-risk group for PWE. To minimize the risk of concussion, a protective concussion headband or helmet may be worn, coach and team players should be aware of the situation, and symptomatic seizure triggers must be avoided.



Figure 2. Concussion helmets

3.4 Handball

Although it is in the low-risk group for PWE, it is possible to be exposed to high acceleration and severe head blows during the game. For this reason, it is necessary to wear a protective helmet and a mouthguard (Figure 2).²⁵

4. Gymnastics

There are several types of gymnastics such as artistic, rhythmic, and aerobic. Gymnastic movements that are performed on the floor have low risk in case of seizures. Rhythmic and aerobic gymnastic are mostly performed on the floor; however, artistic gymnastic includes high bars, vaults, rings and trampolines, which may be risky for PWE since they are performed on heights. General considerations for aerobic sports should be kept in mind, especially avoiding metabolic disturbances. It is safe for people with controlled epilepsy when safety measures are taken and performed under supervision.¹⁶

DISCUSSION

Individuals with epilepsy do not sufficiently participate in sports activities due to some reasons arising from the patients and presumptions of the physicians as well. The hesitation of individuals with epilepsy to do sports is mainly originating from the concern that whether sports and physical exercise are triggering factors for epileptic seizures or not, as well as the fact that the potentiality for injury in case a seizure occurs during physical activity.

Risks Associated with Physical Exercise in Terms of Inducing Seizures

Exercise-related precipitant factors may be metabolic disturbances, head trauma, stress of competition, and change in antiseizure drug levels.⁸

1. Metabolic Factors

The development of hyperthermia, hypoglycemia, hyponatremia, hypoxia, and hyperventilation during exercise are the main metabolic disturbances that PWE can face. These may be observed in sports that include prolonged aerobic exercise sessions. The

mentioned metabolic disturbances may trigger acute symptomatic seizure; however, there is insufficient evidence that PWE is more prone to those.³ Among these, hyponatremia due to overhydration in marathon or triathlon runners, and hypoxia in high-altitude climbers seem to harbour much of a significant risk.⁸ Hypoxia is not much evident in most exercise activities except for high-altitude climbing. Hyperventilation-related respiratory alkalosis does not occur during moderate-intensity exercise because this is thought to be an adaptive response to metabolic demand. Hyperthermia can induce seizures in specific situations such as febrile convulsions however no association was established between exercise-induced hyperthermia and seizures.⁸ Even though rare, it is known that hypoglycemia may induce seizures. To avoid the hypoglycemic effect of prolonged aerobic activity, adequate nutrition should be provided before the exercise.⁸

2. Antiseizure Drugs

Another question is whether exercise can lower antiseizure drug levels by inducing liver enzymes. However, studies have failed to show a significant variation in drug levels during exercise. In the case of clinical necessity, drug levels may be checked.^{3,26}

3. Stress

Stress during sports activities may be another precipitant factor for seizures. This may be important, particularly in patients participating in competitive sports activities. Stress may lead to hypothalamic-pituitary adrenal axis dysregulation and increased sympathetic nervous system activity, which together may result in seizure susceptibility.⁸ It has been shown that chronic stress can lower the seizure threshold.²⁷ Therefore, it is important to distinguish between people who do moderate exercise to gain a healthy lifestyle or as a leisure activity, and who do it for professional purposes. Triggering factors should be evaluated by an individual basis in both groups.³ Competitive sports activities cause stress and fatigue, which might consequently increase the frequency of seizures.⁵ For this reason, it may be preferred for individuals with epilepsy to do these activities as a leisure time activity rather than in a high-stress competition environment.

4. Head Trauma

One of the main concerns of individuals with epilepsy in doing sports is the possibility that a head injury may trigger a seizure. It is known that moderate to severe head trauma may cause posttraumatic epilepsy in the later period.²⁸ However, the relation of minor head trauma and sport-related concussion and seizures are uncertain.⁸ Although it has been reported that convulsive attacks may develop after minor head traumas, it has not been directly related to cause epilepsy, eventually.³ Post-concussive convulsions occur within the seconds of the trauma and lasts for seconds.²⁹ Semiologically, these convulsion types are mainly tonic stiffening followed by myoclonic jerks or asymmetrical posturing. It has been observed that 68% of these convulsions, which may occur after trauma, are in the form of “posturing”. However, after a sports-related concussion, convulsion is the least frequent symptom, while headache and dizziness being the most common symptoms.^{29,30} The general opinion is that minor head injury is unlikely to precipitate a seizure.^{6,29} Unless trauma is repeated, it is not considered a risk factor for epileptogenic march. In the study of Wennberg et al.³¹ including 330 patients with concussion; during 5-10 year follow-up, they have found no increased risk for epilepsy.³² However, the data about the concussive convulsions and post concussion seizures are limited. There are case reports stating postconcussive seizures during football and wrestling.^{33,34} Another point is the impact of repetitive head trauma. Even if the trauma is mild, repetitive head blows may be responsible for epileptogenesis.¹⁰ Thus, it is important to wear a protective headgear in sports with a high risk of head traumas.

Exercise-induced Seizures

However, even very rare, some patients may have seizures precipitated by exercise, which is more common in symptomatic focal epilepsies. Kamel et al.³⁵ reported 10 patients with exercise-induced seizures, who all had symptomatic focal epilepsies. In the study of Nakken³⁶ that includes two hundred and four adults with epilepsy, 10% reported exercise as a seizure precipitant, 2% of which reported a clear association with exercise. This is particularly observed in patients with an underlying structural brain lesion. They have reported that the level of physical exertion is correlated with seizure induction in general. The more vigorous the exercise, the more likely it is to trigger a seizure. However, the type of triggering exercise may change according to the patient. The epileptogenic mechanism of how exercise exerts its effect in this minority of patients is not well known. However, it seems like a similar mechanism in reflex epilepsies, rather than being associated with the metabolic effects of exercise. This is supported by the fact that the majority of exercise-induced epilepsies are mostly temporal lobes of origin.^{2,35,37} Okadome et al.³⁸ reported boxing-induced reflex seizure that is precipitated by a specific motion and resolved by avoiding this motion. Even though regular physical exercise has beneficial effects on seizures in general, if a clear exercise-related trigger is described, this should be taken into consideration while evaluating the patient.

Additionally, in rare specific syndromes such as megalencephalic leukoencephalopathy with subcortical cysts and vanishing white matter disease, exacerbation of symptoms including seizures with minor head trauma may be seen.^{39,40}

Risk of Injury During Sport When Having a Seizure

Another concern regarding physical exercise and epilepsy is the possibility of injury if the person has a seizure during sports activity. This risk is elevated in patients with frequent seizures, generalized seizures, atonic seizures, and patients with mental retardation.³ These patients are at a higher risk of injury during normal daily activities as well. However, the most common type of injury during sports activities is soft tissue injuries.²⁹ Patients with nocturnal seizures and who have aura are at lower risk for injury. In patients with newly diagnosed epilepsy, care should be taken and risky sports should be avoided for a period. The type of sports is also important in this respect. Group 3 sports according to the ILAE report involve high risk of injury, therefore should not be recommended to uncontrolled epilepsies. However, they may be recommended with caution in controlled epilepsy on an individual-based approach.⁶

General Recommendations

It is necessary for the person to wear protective equipment suitable for each sport type (life jacket and goggles for water sports; helmet for martial arts, horse riding, contact sports; wristband that provides vital information and a localizer device of the individual for outdoor sports, harness for cycling and horse riding etc); to take countermeasures for seizure-triggers (for runners hydration, nutrition and appropriate clothing; for climbers adequate oxygenation etc.), and to have a trained supervisor who is educated about the athlete’s medical condition and trained for cardiopulmonary resuscitation (Table 2).

A patient-based approach should be followed according to the clinical characteristics of the patient. In patients with frequent seizures, seizures with impaired awareness, recent diagnosis of epilepsy, seizures without aura, and seizures during the day; precautions according to the sports branch should be discussed with them. Seizure triggering factors should be questioned. Patients’ drug compliance should be taken into consideration for the final decision. Patients’ risk tolerance is another determining factor of the decision (Table 1).

Beneficial Effects of Exercise on PWE

Generally, it has been proven that exercise is good for the cardiovascular system and psychosocial, and physiological well-being. Additionally, it reduces neuronal damage and cell loss and improves the quality of life and neurocognitive outcomes in PWE.⁷ It increases cognitive capacity by showing positive effects on attention, memory, and concentration, improves sleep quality, increases self-esteem and improves mood by reducing depression

Table 2. The possible protective equipment for particular sports branches

Helmets/concussion helmets	Martial arts, collective contact sports, cycling, climbing, horse riding
Goggles/sunglasses	Water sports, skiing, and outdoor sports
Life jacket	Water sports
Protective pads	Contact sports and outdoor sports
Electronic localizer device	Mountaineering, hiking, and rafting
Harness	Horse riding, cycling

and anxiety, and protects against osteoporosis. Additionally, it may cause a possible reduction in seizure frequency by several mechanisms. Animal models and clinical studies have shown a decrease in interictal discharges during exercise and additionally seizure occurrence.^{2,41-43} Several mechanisms are proposed which include, release of B-endorphins, noradrenaline, and GABA during exercise, release of steroids secondary to stress, increase in melatonin, increase in parvalbumin, and generation of structural changes within the hippocampus.² The regular practice of physical exercise enhances the levels of brain-derived neuro factor in the hippocampus, induces neurogenesis, inhibits oxidative stress and reactive gliosis, avoids cognitive impairment, decreases the production of pro-inflammatory and stress biomarkers, and stimulates the production of dopamine in the epileptic brain.^{8,44}

CONCLUSION

Traditionally, there has been a tendency to avoid physical activity and sports in PWE. However, this trend has started to change with the recognition of the positive effects of sports on health in PWE. Sports activities are of physiological, social, and psychological importance for individuals with epilepsy and for every other person. To increase the biopsychosocial well-being and social participation of PWE, the most appropriate sports branch should be found, necessary education and training should be given, and people should be encouraged to exercise under competent supervision. People should be in close contact with their physician and should be informed about the necessary practices before, during, and after the activity. When appropriate precautions are taken in patients with epilepsy, sports will be accepted as a therapeutic entity rather than a ban.

Ethics

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Authorship Contributions

Surgical and Medical Practices: Ö.E.Ç., Concept: Ö.E.Ç., Design: Ö.E.Ç., Data Collection or Processing: Ö.E.Ç., O.U., Analysis or Interpretation: Ö.E.Ç., O.U., Literature Search: Ö.E.Ç., O.U., Writing: Ö.E.Ç., O.U.

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References

1. Arida RM, Cavaleiro EA, da Silva AC, Scorza FA. Physical activity and epilepsy: proven and predicted benefits. *Sports Med.* 2008;38(7):607-615. [\[CrossRef\]](#)
2. Carrizosa-Moog J, Ladino LD, Benjumea-Cuartas V, et al. Epilepsy, Physical Activity and Sports: A Narrative Review. *Can J Neurol Sci.* 2018;45(6):624-632. [\[CrossRef\]](#)
3. Pimentel J, Tojal R, Morgado J. Epilepsy and physical exercise. *Seizure.* 2015;25:87-94. [\[CrossRef\]](#)
4. Bjørholt PG, Nakken KO, Røhme K, Hansen H. Leisure time habits and physical fitness in adults with epilepsy. *Epilepsia.* 1990;31(1):83-87. [\[CrossRef\]](#)
5. Howard GM, Radloff M, Sevier TL. Epilepsy and sports participation. *Curr Sports Med Rep.* 2004;3(1):15-19. [\[CrossRef\]](#)
6. Capovilla G, Kaufman KR, Perucca E, Moshé SL, Arida RM. Epilepsy, seizures, physical exercise, and sports: A report from the ILAE Task Force on Sports and Epilepsy. *Epilepsia.* 2016;57(1):6-12. [\[CrossRef\]](#)
7. Duñabeitia I, Bidaurrezaga-Letona I, Diz JC, Colon-Leira S, García-Fresneda A, Ayán C. Effects of physical exercise in people with epilepsy: A systematic review and meta-analysis. *Epilepsy Behav.* 2022;137(Pt A):108959. [\[CrossRef\]](#)
8. Arida RM. Physical exercise and seizure activity. *Biochim Biophys Acta Mol Basis Dis.* 2021;1867(1):165979. [\[CrossRef\]](#)
9. Arida RM, Sales EPD, Teixeira-Machado L, Prado GFD, Gutierrez RC, Carrizosa J. Neurologists' knowledge of and attitudes toward physical exercise for people with epilepsy in Latin America. *Epilepsy Behav.* 2022;131(Pt A):108705. [\[CrossRef\]](#)
10. MacMullin P, Hodgson N, Damar U, et al. Increase in Seizure Susceptibility After Repetitive Concussion Results from Oxidative Stress, Parvalbumin-Positive Interneuron Dysfunction and Biphasic Increases in Glutamate/GABA Ratio. *Cereb Cortex.* 2020;30(12):6108-6120. [\[CrossRef\]](#)
11. World Karate Federation. Dec 29 2022. Available from: <https://www.wkf.net/structure-statutes-rules> [\[CrossRef\]](#)
12. Koh JO, Cassidy JD. Incidence study of head blows and concussions in competition taekwondo. *Clin J Sport Med.* 2004;14(2):72-79. [\[CrossRef\]](#)
13. International Judo Federation. Dec 29 2022. Available from: <https://rules.ijf.org/>. [\[CrossRef\]](#)
14. Arida RM, Vieira DE, Cavaleiro EA, Scorza FA. Judo: Ippon scored against epilepsy. *Epilepsy Behav.* 2010;17(1):136. [\[CrossRef\]](#)
15. Jäggi U, Joray CP, Brühlhart Y, Luijckx E, Rogan S. Verletzungen in den Kampfsportarten Judo, Taekwondo und Ringen - Eine systematische Übersichtsarbeit [Injuries in the Martial Arts Judo, Taekwondo and Wrestling - A Systematic Review]. *Sportverletz Sportschaden.* 2015;29(4):219-225. [\[CrossRef\]](#)
16. Epilepsy Foundation. Jan 5 2023. Available from: <https://www.epilepsy.com>. [\[CrossRef\]](#)
17. Aikido Journal. Jan 2 2023. Available from: <https://aikidojournal.com>. [\[CrossRef\]](#)
18. Davis DP, Videen JS, Marino A, et al. Exercise-associated hyponatremia in marathon runners: a two-year experience. *J Emerg Med.* 2001;21(1):47-57. [\[CrossRef\]](#)
19. Epilepsy Society. Jan 4 2023. Available from: <https://epilepsysociety.org.uk>. [\[CrossRef\]](#)
20. Bell GS, Gaitatzis A, Bell CL, Johnson AL, Sander JW. Drowning in people with epilepsy: how great is the risk? *Neurology.* 2008;71:578-582. [\[CrossRef\]](#)
21. Epilepsy action australia. Jan 5 2023. Available from: <https://www.epilepsy.org.au>. [\[CrossRef\]](#)
22. Almeida MR, Bell GS, Sander JW. Epilepsy and recreational scuba diving: an absolute contraindication or can there be exceptions? A call for discussion. *Epilepsia.* 2007;48(5):851-858. [\[CrossRef\]](#)
23. McCrory PR, Bladin PF, Berkovic SF. Retrospective study of concussive convulsions in elite Australian rules and rugby league footballers: phenomenology, aetiology, and outcome. *BMJ.* 1997;314(7075):171-174. [\[CrossRef\]](#)
24. Alexander HB, Wright CJ, Taplinger DH, Fountain NB. Incidence of seizure exacerbation and injury related to football participation in people with epilepsy. *Epilepsy Behav.* 2020;104(Pt A):106888. [\[CrossRef\]](#)
25. Daneshvar DH, Baugh CM, Nowinski CJ, McKee AC, Stern RA, Cantu RC. Helmets and mouth guards: the role of personal equipment in preventing sport-related concussions. *Clin Sports Med.* 2011;30(1):145-163. [\[CrossRef\]](#)
26. Nakken KO, Bjørholt PG, Johannessen SI, Løyning T, Lind E. Effect of Physical Training on Aerobic Capacity, Seizure Occurrence, and Serum Level of Antiepileptic Drugs in Adults with Epilepsy. *Epilepsia.* 1990;31(1):88-94. [\[CrossRef\]](#)
27. Espinosa-García C, Zeleke H, Rojas A. Impact of Stress on Epilepsy: Focus on Neuroinflammation-A Mini Review. *Int J Mol Sci.* 2021;22(8):4061. [\[CrossRef\]](#)
28. VanItallie TB. Traumatic brain injury (TBI) in collision sports: Possible mechanisms of transformation into chronic traumatic encephalopathy (CTE). *Metabolism.* 2019;100S:153943. [\[CrossRef\]](#)
29. Carter JM, McGrew C. Seizure Disorders and Exercise/Sports Participation. *Curr Sports Med Rep.* 2021;20(1):26-30. [\[CrossRef\]](#)

30. Kuhl NO, Yengo-Kahn AM, Burnette H, Solomon GS, Zuckerman SL. Sport-related convulsive convulsions: a systematic review. *Phys Sportsmed*. 2018;46(1):1-7. [\[CrossRef\]](#)
31. Wennberg R, Hiploylee C, Tai P, Tator CH. Is Concussion a Risk Factor for Epilepsy? *Can J Neurol Sci*. 2018;45(3):275-282. [\[CrossRef\]](#)
32. Fordington S, Manford M. A review of seizures and epilepsy following traumatic brain injury. *J Neurol*. 2020;267(10):3105-3111. [\[CrossRef\]](#)
33. Kravljanac R, Ilić N, Kravljanac D. Concussive seizure in a 16-year-old football goalkeeper. *Epileptic Disord*. 2021;23(3):531. [\[CrossRef\]](#)
34. Meehan WP, Hoppa E, Capraro AJ. Focal motor seizure in a wrestler with a sport-related concussion. *Phys Sportsmed*. 2008;36(1):125-128. [\[CrossRef\]](#)
35. Kamel JT, Badawy RA, Cook MJ. Exercise-induced seizures and lateral asymmetry in patients with temporal lobe epilepsy. *Epilepsy Behav Case Rep*. 2014;2:26-30. [\[CrossRef\]](#)
36. Nakken KO. Physical exercise in outpatients with epilepsy. *Epilepsia*. 1999;40(5):643-651. [\[CrossRef\]](#)
37. Sturm JW, Fedi M, Berkovic SF, Reutens DC. Exercise-induced temporal lobe epilepsy. *Neurology*. 2002;59(8):1246-1248. [\[CrossRef\]](#)
38. Okadome T, Takeuchi H, Yamaguchi T, et al. Shadowboxing-induced reflex seizures in a patient with focal epilepsy. *Epilepsy Behav Rep*. 2022;19:100543. [\[CrossRef\]](#)
39. van der Knaap MS, Abbink TEM, Min R. Megalencephalic Leukoencephalopathy with Subcortical Cysts. Margaret P Adam, David B Everman, Ghayda M Mirzaa, Roberta A Pagon, Stephanie E Wallace, Lora JH Bean, Karen W Gripp, Anne Amemiya, editors. In: GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993. 2003 Aug 11 [updated 2018 Mar 29]. [\[CrossRef\]](#)
40. Köhler W, Curiel J, Vanderver A. Adulthood leukodystrophies. *Nat Rev Neurol*. 2018;14(2):94-105. [\[CrossRef\]](#)
41. Nakken KO, Løyning A, Løyning T, Gløersen G, Larsson PG. Does physical exercise influence the occurrence of epileptiform EEG discharges in children? *Epilepsia*. 1997;38(3):279-284. Erratum in: *Epilepsia*. 1997;38(8):956. [\[CrossRef\]](#)
42. Vancini RL, de Lira CA, Scorza FA, et al. Cardiorespiratory and electroencephalographic responses to exhaustive acute physical exercise in people with temporal lobe epilepsy. *Epilepsy Behav*. 2010;19(3):504-508. [\[CrossRef\]](#)
43. de Lima C, Vancini RL, Arida RM, et al. Physiological and electroencephalographic responses to acute exhaustive physical exercise in people with juvenile myoclonic epilepsy. *Epilepsy Behav*. 2011;22(4):718-722. [\[CrossRef\]](#)
44. Cavalcante BRR, Improtá-Caria AC, Melo VH, De Sousa RAL. Exercise-linked consequences on epilepsy. *Epilepsy Behav*. 2021;121(Pt A):108079. [\[CrossRef\]](#)