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Original Article

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Impact of Exercise Intervention on Cardiovascular Fitness in Patients with Epilepsy: A Quasi-experimental Study

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ABSTRACT

Introduction: Epilepsy is a disorder characterised by two or more recurrent seizures that are unprovoked by any immediately identifiable cause. Additionally, it can lead to psychological issues, including anxiety and depression, as well as societal problems such as increased social stigma and withdrawal. Physical exercise regimens incorporated into the treatment plan can benefit epilepsy patients; however, these are often not included by medical experts or epilepsy patients themselves due to the stigma associated with the condition, apprehension that exercise might trigger seizures, or a lack of knowledge about the benefits of physical activity.

Aim: To evaluate the effect of physical exercise on cardiovascular endurance and fitness levels in adults with and without epilepsy.

Materials and Methods: A quasi-experimental study consisting of a pre-and post-design with a control group was conducted over a duration of six months. For both groups, participants were given exercise interventions three times a week for six months (from March 2022 to August 2022), with each session lasting 60 minutes. The outcome measures evaluated included the Shuttle Walk Test (SWT) and maximal oxygen consumption (VO_2 max). For normally distributed data, an unpaired t-test was used to compare data between groups, while repeated measures Analysis of Variance (ANOVA) was used to compare data within the same group. A significance level of p-value ≤0.05 was considered.

Results: The mean SWT scores in the control group at baseline, at the end of the 1st month, the 3rd month, and the 6th month were 6.62±1.32 m, 6.94±3.62 m, 7.46±2.69 m, and 8.36±3.16 m, respectively. In the experimental group, the mean SWT scores were 5.96±0.02 m, 6.68±2.24 m, 7.02±1.41 m, and 7.90±2.08 m, respectively. The mean VO_2 max values in the experimental group at baseline, at the end of the 1st month, the 3rd month, and the 6th month were 29.76±4.29 m, 30.24±4.01 m, 33.40±2.17 m, and 35.45±3.68 m, respectively. In the control group, the mean VO_2 max values were 29.59±5.68 m, 30.09±5.60 m, 31.22±3.48 m, and 33.88±4.26 m, respectively.

Conclusion: The study concluded that the physical exercise intervention conducted for adults with and without epilepsy improved cardiovascular fitness and aerobic endurance. Therefore, patients with epilepsy should be encouraged to participate in some form of physical activity.

Keywords: Antiepileptic drugs, Cardiovascular endurance and fitness, Epileptic seizures, Physical exercise, Shuttle walk test

INTRODUCTION

Neurobiological, cognitive, psychological, and societal problems result in elevated social stigma and withdrawal, leading to high rates of anxiety and depression. The International League Against Epilepsy (ILAE, 1993) defines epilepsy as a disorder characterised by repeated (two or more) epileptic seizures that are unprovoked by any immediately identified cause. Approximately, 50 million people worldwide suffer from epilepsy. Consequently, the World Health Organisation (WHO) reported that 80% of those with epilepsy reside in developing countries. One-fifth of those suffering from epilepsy live in India [1,2]. The incidence of epilepsy in the community is roughly 1%, and according to current literature, the general incidence of epilepsy in India ranges between 5.50 and 10 per 1,000 persons [3].

Chronic epilepsy has consequences that extend beyond the harm caused by recurring seizures. In addition to the negative effects of Antiepileptic Drugs (AEDs), patients often experience cognitive impairment [4]. Psychosocial impairment, along with elevated levels of anxiety and depression, is generally closely associated with epilepsy. Given the intricate interactions among seizures, AED effects, co-morbidities, and stigma, it is not surprising that many of these individuals experience a poor Quality of Life (QoL) [5]. To improve QoL in epilepsy, efforts should focus not only on seizure management but also on all aspects of living, including physical and psychological wellbeing [6,7].

Recent studies have shown that physical exercise regimens are not frequently incorporated by medical experts or epilepsy patients. This hesitation may stem from concerns that exercise could trigger seizures, stigma, or a lack of knowledge [6,8]. Regular exercise programs have been shown to benefit patients with epilepsy both physiologically and psychologically [9,10]. Exercise programs help individuals with epilepsy experience fewer seizures than sedentary patients, although the reasons and mechanisms behind this effect have not been firmly established [6,11].

Daily physical activity and fitness can boost energy, promote blood flow, build muscle tone, enhance heart health, and improve coordination and balance. Regular workouts can increase the synthesis and release of serotonin, norepinephrine, and dopamine, upregulate neurotrophins, reduce stress, and thus decrease hypothalamic- pituitary- adrenal activity and adrenal glucocorticoids [6]. As a result, an individual's mood may improve, and they may experience less anxiety or depression. Prior research have found that people with temporal lobe epilepsy exhibited improvements in physical ability, overall health, and psychological condition. Therefore, the aim of the present study was to evaluate the effect of physical exercise on cardiovascular endurance or fitness levels in adults with and without epilepsy. The null hypothesis of the study posited statistically significant effects of physical exercise on cardiovascular endurance or fitness levels in adults with and without epilepsy, while the alternative hypothesis suggested statistically insignificant effects of physical exercise on cardiovascular endurance or fitness levels in these groups.

MATERIALS AND METHODS

This quasi-experimental study is part of a larger research project which is yet to be published consisting of a pre-and post-design with a control group. The study was conducted after obtaining permission from the Institutional Ethical Committee (IEC) with reference number SVIEC/ON/Phys/PhD/20026. The research took place at KJ Somaiya College of Physiotherapy over a duration of six months (from March 2022 to August 2022).

Inclusion criteria: The inclusion criteria for the experimental group consisted of epilepsy patients aged between 18 and 50 years, involving both genders. Participants had to have non-institutionalised idiopathic, generalised, or focal epilepsy, be seizure-free for the past six months, and be physically active or ambulatory. The control group consisted of males and females aged 18 to 50 years who were self-declared healthy and not on any medications.

Exclusion criteria: The exclusion criteria included neurological disorders, including acute and chronic illnesses other than epilepsy; patients with any injuries or previous surgeries; patients with pacemakers, pregnancy, or cancer; individuals with major congenital malformations; chronic or inflammatory diseases such as diabetes mellitus and thyroid dysfunction; and those who were already exercising regularly.

Based on these criteria, a total of 100 participants were included in the present study through convenient sampling techniques. They were equally and randomly assigned to two groups.

Sample size calculation: The sample size was calculated using Open Epi Version 3 Open Source Calculator, with the formula used being $n=\{DEFF * Np(1-p)\}/\{(d^2/Z^2(1-\alpha/2)*(N-1)+p* (1-p))\}$ [12]. This calculation yielded n=24+10% of 24, resulting in n=26.4 ~ 27, where absolute precision was considered at 4%, the level of significance at 5%, and the confidence interval at 95%. The minimum sample size, according to the sample size calculation, was 27 for each group but was increased to 50 samples in each group. Group A consisted of the experimental or interventional group, which included 50 epilepsy patients, while Group B consisted of the control group, which included 50 participants without epilepsy. Before commencing the intervention, written informed consent was obtained from the participants in both groups.

Study Procedure

For both groups, based on the baseline values of the SWT and VO_2 max, participants were given 10 minutes of warm-up exercises, followed by 40 minutes of aerobic exercises, and concluded with 10 minutes of cool-down exercises. The exercises were performed according to the tolerance levels of the patients, consisting of up to three sets of 10 repetitions each, for six months, three times a week, with each session lasting 60 minutes. Based on the changes observed in the participants' SWT and VO_2 max, modifications to their exercise program were made, which involved a decrease in repetitions or sets depending on the participants' tolerance levels.

The primary outcome measure evaluated was the SWT [13], while the secondary measure was VO_2 max. Both were assessed at baseline (immediately after recruitment, on day one), at the end of the 1st month, the 3rd month, and the 6th month. For the SWT, individuals walked back and forth between two locations or around a 10-meter track, frequently increasing their walking pace by small increments after each shuttle completion. The mean SWT scores were then calculated [13]. The VO_2 max was calculated using the formula: 15.3 x (maximum heart rate/resting heart rate) [14,15].

STATISTICAL ANALYSIS

The collected data were summarised using descriptive statistics, including frequency, percentage, mean, and standard deviation. For normally distributed data, an unpaired t-test was used to compare data between groups, while repeated measures ANOVA was employed to compare data within the same group. The level of significance considered was a p-value ≤0.05.

RESULTS

Overall, 50 epilepsy patients (experimental group) and 50 normal participants (control group) were recruited for this research. The age distribution of participants demonstrated that the highest number, consisting of 48 individuals, was in the age range of 41-50 years, followed by 38 participants in the age range of 31-40 years, and 14 participants in the age range of 18-30 years. Additionally, the gender distribution reported that the majority of participants in the present study were female, comprising 59 (59%) participants, compared to 41 (41%) males.

The mean SWT scores of the participants are presented in [Table/Fig-1].

Group	Shuttle Walk Test (m)				
	Baseline	At the end of 1st month	At the end of 3rd month	At the end of 6th month	One-way ANOVA
Experimental	5.96±0.02	6.68±2.24	7.02±1.41	7.9±2.08	10.6824 p-value= 0.02222, S
Control	6.62±1.32	6.94±3.62	7.46±2.69	8.36±3.16	
Unpaired t-test (p-value)	0.0005, S	0.6668, NS	0.3081, NS	0.392, NS	

[Table/Fig-1]: Mean SWT scores of participants at the baseline level, at the end of the first, third and sixth month.
SWT: Shuttle walk test; S: Significant; NS: Non-significant

When the experimental group and control group were analysed using an unpaired t-test, a statistically significant p-value (0.0005) was found at baseline, while statistically non significant p-values were observed at the end of the 1st month (0.6668), the end of the 3rd month (0.3081), and the end of the 6th month (0.392). However, when an ANOVA test was applied to compare the data within the same group, the results were found to be statistically significant (p-value=0.02222).

The mean VO_2 max values of the participants are presented in [Table/Fig-2].

Group	VO_2 max (mL/kg/min)				
	Baseline	At the end of 1st month	At the end of 3rd month	At the end of 6th month	One-way ANOVA
Experimental	29.76±4.29	30.24±4.01	33.40±2.17	35.45±3.68	11.4611 p-value= 0.01964, S
Control	29.59±5.68	30.09±5.60	31.22±3.48	33.88±4.26	
Unpaired t-test (p-value)	0.8662, NS	0.8698, NS	0.0003, S	0.05, S	

[Table/Fig-2]: Mean VO_2 max values of participants at the baseline level, at the end of the first, third and sixth month.
VO_2 max: Maximal oxygen consumption; S: Significant; NS: Non-significant

When the experimental group and control group were analysed using an unpaired t-test, statistically non significant p-values (0.8662) were found at baseline and at the completion of the first month (0.8698). Statistically significant results were found at the end of the third month (0.0003) and at the completion of the sixth month (0.05). However, when an ANOVA test was applied to compare the data within the same group, the results were found to be statistically significant (p-value=0.01964).

DISCUSSION

The purpose of the present study was to determine the effectiveness of a physical exercise intervention on fitness in adults with or without epilepsy. Based on the selection criteria, a total of 100 participants were recruited for the study and allocated into two groups: Group A, consisting of 50 epilepsy patients, and Group B, consisting of 50 normal participants. The results demonstrated that the SWT and VO_2 max, which were used to measure cardiovascular fitness and aerobic endurance, showed progressive increases in scores from baseline to the end of the 6th month in both groups. However, the control group exhibited better SWT scores compared to the experimental group, while more positive outcomes related to VO_2 max values were observed in the experimental group compared to the control group.

The age-wise distribution of participants ranging from 18 to 50 years demonstrated that the maximum number of participants, consisting of 48, were in the age range of 41 to 50 years, followed by 38 participants in the age range of 31 to 40 years, and 14 participants in the age range of 18 to 30 years. Additionally, a greater number of participants were female, with 59 females compared to 41 males. Similarly, a study conducted by Volpato N et al., allocated participants into two groups: an experimental group involving epilepsy patients aged 23 to 59 years, with a mean age of 43±10.16 years, and a control group aged 27 to 58 years, with a mean age of 46±8.43 years. Furthermore, the majority of patients in both groups were female. The experimental group consisted of 24 females and 14 males, while the control group included 13 females and seven males [1].

The mean SWT scores in the experimental group at baseline, and at the end of the 1st month, 3rd month, and 6th month, showed an increase in scores from baseline to the end of the 6th month, with better scores in the control group compared to the experimental group. Similarly, a study by Rauchenzauner et al., using the 6-minute walk test for endurance showed no difference between children with epilepsy and the control group. Additionally, a study by Steinhoff BJ et al., employed a 2-km walking test for endurance assessment, in which the majority of patients scored between 1 and 3, indicating very good, good, and sufficient results, respectively [16].

Moreover, van den Bongard F et al., reported in their review that adults with epilepsy are, in comparison to the general population, physically less active and fit, which was associated with reduced QOL and increased co-morbidities [17]. Furthermore, a previous study by Sırtbaş G et al., found that the results of physical fitness tests (the flamingo balance test and trunk-lift test) were significantly lower in children with epilepsy [18]. Based on these findings, raising awareness among families and health professionals is essential to motivate children toward increased physical activity to enhance their endurance and fitness.

The mean VO_2 max values in the experimental group at baseline, at the end of the 1st month, 3rd month, and 6th month showed a progressive increase in scores from baseline to the end of the 6th month, with better scores in the experimental group compared to the control group. Similarly, a study presented by Nakken KO et al., demonstrated that aerobic capacity, as a percentage corrected for age and sex relative to the normal population (100%), improved after a four-week intensive training program. The pretraining results for males and females were reported as 75% and 80%, respectively, and after training, these results increased to 94% and 96%, signifying a positive outcome of physical activity in patients with epilepsy [19]. Additionally, a study by Volpato N et al., reported that the control group exhibited better physical activity levels compared to individuals with epilepsy, as measured quantitatively using a cardiopulmonary test. VO_2 max is utilised to evaluate cardiopulmonary co-morbidities and to assess general health [1].

Physical exercise increases circulating levels of calcium, stimulates the synthesis of dopamine, and regulates several brain functions [20]. Epilepsy patients who participate in a physical exercise program have shown improvements in maximum aerobic capacity, work capacity, body composition, and self-esteem, leading to psychological and social enhancements [19]. Moreover, during and after physical exercise, there is a greater production of β-endorphins and steroids. Their release into the bloodstream appears to alter abnormal neuronal electrical activity, minimising the frequency of seizures [21]. Similarly, a previous study involving an aerobic and resistance training program for epilepsy patients found that regular training promoted brain plasticity, improved functional connectivity of the brain, enhanced memory, and resulted in increased maximum voluntary strength [22].

It has been reported that physical exercise does not significantly alter the concentration of AEDs in serum; however, physical exercise modifies the metabolism of certain liver enzymes, which can decrease oxidative stress and hepatotoxicity produced by AEDs, especially through the oxidative metabolic pathway that is predominantly activated during aerobic exercise [23]. Interestingly, the increased activity of this pathway during and after exercise, along with the consequent release of free fatty acids into the bloodstream, may result in competition with the albumin transporter- also a transporter for AEDs- leading to elevated drug concentrations in the blood, without affecting the incidence and intensity of seizures [23,24].

The care taken throughout a seizure episode is alarmingly important, as careful attention and a positive mindset both prior to and after the seizure can aid in reducing the medical and psychological consequences of the incident. Understanding attitudes toward physical activity may allow clinicians to address fears and reassure both epilepsy patients and their families and friends. Initiatives aimed at increasing awareness and educating people about epilepsy are essential for changing the way the condition is viewed and for encouraging those who suffer from it to seek treatment. Moreover, raising awareness is the quickest, most effective, and least expensive strategy to eliminate the stigma attached to this ailment. Furthermore, therapists in practice have a thorough understanding of the management of seizure episodes; therefore, education on societal myths and taboos should be incorporated into the curriculum to help therapists become more aware of these issues. Since therapists are the future decision-makers and leaders in their careers and communities, it is imperative that students at all levels receive education about this illness from both a medical and social perspective, which will consequently reduce the stigma associated with epilepsy in society. The strength of the present study lies in the progressive increase in fitness levels among participants in both groups.

Limitation(s)

The limitations of the present study include a shorter follow-up duration of only six months, and the study involved only the adult population. Therefore, future research should focus on the paediatric population, include a larger sample size, and consider gender-wise distribution of mean values concerning VO_2 max, as well as longer follow-up durations.

CONCLUSION(S)

The study highlighted the effectiveness of physical exercise interventions on fitness in adults with and without epilepsy by demonstrating significant outcomes from baseline to the end of the sixth month. Physical exercise improves cardiovascular fitness and aerobic endurance in both epilepsy patients and the general adult population; therefore, participation in some form of physical activity should be encouraged. Physical activity as a non pharmacological treatment to assist epilepsy patients has progressively attracted attention. Despite encouraging results in the literature, participation in physical exercise among epilepsy patients remains low. This issue can be addressed by raising awareness and facilitating educational initiatives to improve perspectives toward epilepsy patients and encourage them to seek and engage in physical exercise interventions.

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