



## Equine-assisted therapy in quality of life and functioning of people with active epilepsy: A feasibility study

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### ABSTRACT

People with active epilepsy, which is often associated with specific neurological conditions, endure significant impairments in quality of life (QoL) and functioning, particularly those in middle-income countries. Physical intervention plays an essential role in addressing these challenges. This study investigated the impact of equine-assisted therapy (EAT) on QoL, functional independence, sleep quality, antiseizure medications, and frequency of seizures among people with epilepsy (PWE), with or without additional neurological conditions. Fourteen participants aged 4–34 years old diagnosed with focal epilepsy participated in a structured EAT program. The EAT program consisted of 36 sessions, each lasting 30 min and conducted weekly. Data were collected at four different times: baseline (T1), after 12 sessions (T2), after 24 sessions (T3), and after 36 sessions (T4). The assessments included the Quality of Life in Epilepsy (QOLIE-31), Functional Independence Measure (FIM), Pittsburgh Sleep Quality Index (PSQI), and Liverpool Adverse Event Profile (LAEP) scores. Seizure frequency was monitored continuously. Horse welfare was evaluated using the Horse Welfare Assessment Protocol (HWAP). After the EAT intervention, significant improvements were observed in the QoL scores (from 62.18 [57.88 – 70.25] to 80.18 [65.30 – 86.78]) and in FIM values (from 70.00 [36.50 – 97.75] to 70.00 [51.75 – 116.75]), particularly in the self-care and social cognition domains. Additionally, there was also a decrease in seizure frequency, adverse effects of antiseizure medications, and sleep quality. The HWAP indicated satisfactory welfare conditions for the horses. These findings indicate that EAT holds promise as a therapeutic intervention for improving the QoL and functioning of PWE. Tailored interventions are essential to address the diverse challenges faced by PWE, emphasizing the need for further research on effective therapeutic approaches.

### 1. Introduction

Epilepsy is a chronic neurological condition that can have a profound impact on various aspects of life. The associated increase in excitability can be triggered by either genetic factors or brain injuries, resulting in sudden and temporary irregularities in a variety of areas, including motor function, sensory perception, autonomic responses, involuntary psychological changes, and alterations in consciousness [1,2].

Research dedicated to understanding the functioning activity, social participation, and quality of life (QoL) of people with epilepsy (PWE) is not only a medical concern, but also an ethical and societal priority.

Individuals with epilepsy have complex needs that must be addressed to enable them to live independently [3]. By focusing on strategies that promote the QoL and enhance functional independence for PWE, we can better understand the challenges faced by PWE, including the physical and emotional impact of seizures, side effects of medications, and social stigma associated with active epilepsy [3–5].

Equine-assisted therapy (EAT) is a therapeutic method that incorporates interdisciplinary approaches, combining recreational and sporting strategies in a multisensory environment. This study used a therapy/adaptive riding strategy, as prior research has shown that the rhythmic movement of horseback riding simulates human gait and

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promotes positive effects on health across the social, emotional, and physical domains by stimulating the sensory, neuromotor, and cognitive systems [6,7].

The physical benefits of horseback riding include improved postural control [7], muscle activation [8], proprioception [9], and balance [10]. These improvements are triggered because the horse creates three-dimensional movements that involve displacements in the vertical (up and down), transverse (forward and backward), and horizontal (right and left) directions [10]. The associated social and emotional benefits include increased attention, communication, learning, and social skills in individuals with disabilities [11]. Furthermore, being in contact with nature during this activity can improve well-being and general health, reduce morbidity, and increase life expectancy [12]. As such, EAT is widely applied as a therapeutic strategy to enhance the QoL and function [13–18]. Indeed, studies have shown positive effects of EAT on neuropsychological conditions, such as cerebral palsy (CP) [13], autism spectrum disorder (ASD) [17], anxiety, and post-traumatic stress [18]. However, there is a lack of evidence on EAT improving QoL and functioning in PWE.

The importance of this study lies in its recognition of the necessity for supportive approaches beyond the medical treatment of PWE. Overall, this study hypothesized that EAT can create a therapeutic environment to aid in alleviating some of the cognitive and emotional challenges associated with epilepsy, such as reducing seizure frequency and minimizing the adverse effects of medications. This study examined the potential influence of EAT on functional independence, sleep quality, seizure frequency, adverse effects of antiseizure medications, and overall QoL in PWE.

## 2. Material and methods

### 2.1. Study design and ethical considerations

This prospective feasibility study addressed the QoL and functional independence scores of PWE who practiced EAT. The welfare of the horses used during the sessions was also evaluated. All participants and their parents or caregivers signed a consent form to participate in the study. This study was approved by the Human Research Ethics Committee (number 5.685.082) and the Animal Research Ethics Committee (number 5.594.211).

### 2.2. Setting

The EAT protocol was performed in nature, which provides a peaceful setting for healing and personal growth. The location was the Center of EAT at Lagarto City, Sergipe, northeast Brazil.

### 2.3. Human participants

Participants were recruited through convenience sampling from the Centro Lagartense de Equoterapia (CLE) in Lagarto, Sergipe, Brazil. The inclusion criteria were individuals diagnosed with epilepsy by a neurologist, with or without overlapping conditions; who were attending CLE; were between the ages of 5 and 35 years; had experienced epileptic seizures; and had no contraindications to horseback riding. Individuals under 2 years of age and those whose seizures were difficult to control with medication were excluded. Seizures can present in different ways, including horseback riding, such as convulsions, clonic seizures (sudden rhythmic and sustained movements), and tonic-clonic seizures (generalized rigidity involving all limbs, without any sudden rhythmic movements). These manifestations can make handling the participant challenging due to worrying about the horse during the intervention.

### 2.4. Study size

We determined the sample size using a purposeful sampling method guided by the principles outlined by Patton [19] and Yin [20]. This approach aimed to provide a nuanced understanding of experiences within the unique context of the therapeutic riding center, following Yin's [20] guidance on purposeful sampling for an in-depth exploration of specific phenomena.

### 2.5. Horses

The horses used in the EAT sessions were of short stature (average height, 1.4 m) and could perform three regular gaits: walking, trotting, and galloping. These animals did not show any alterations in their body structure, were over 5 years old, all male, and castrated to reduce potential aggressiveness due to testosterone. All horses were obedient, docile, tolerant, enjoyed being close to humans, and were de-sensitized to different stimuli. Assessments were conducted regularly to monitor the horses' behavior, facilitating the implementation of appropriate domestication and training techniques to encourage desirable behaviors and correct any vices or excessive reactions.

### 2.6. Intervention protocol

Triplanar motion refers to the movement in three planes: sagittal (forward and backward), frontal (side-to-side), and transverse (rotational). These three-dimensional movements are natural for horses while walking and performed outdoors. Horses were the main therapeutic tools in this study, with participants adopting different mounting positions and navigating through different paces and surfaces. The sessions included various accessories, such as balls and sticks, to improve motor coordination and skills. The EAT sessions were divided into three phases:

1. Approach and practitioner adaptation to the horse and relaxation: The first 5 min always involved riding on flat terrain with a soft surface (grass or sand) at a walking pace. This phase allowed the participant to establish a connection with the horse, therapist, and entire team.
2. Activities (muscle strength gain, balance, and motor coordination): Activities were conducted using pedagogical and motor coordination toys (e.g., hula hoops, colored balls, animal figures, transportation and fruit props, musical toys, and musical instruments). These activities were performed on different types of surfaces, such as cobblestones, asphalt, soil, gravel, inclines, and declines, in various riding positions, including side, rear, front, and double. The activities included different gaits (walk and trot) and lasted for 20 min.
3. Farvey: This phase involved slowing down the participants to a walking pace. It included distractions and free-riding through the space until reaching a ramp, which lasted for 5 min.

### 2.7. Variables of interest, data sources and measurements

Sociodemographic data, such as age, sex, weight, height, education, occupation, marital status, and monthly income; and epilepsy-related factors, including age at the first epileptic episode, age at epilepsy diagnosis, family history of epilepsy, and details regarding medication use, were collected to understand participants' profiles. The frequency of epileptic seizures was monitored during the study period.

This study assessed the following outcomes using validated assessments:

QoL was assessed using the QoL in Epilepsy (QOLIE-31) scale, which is divided into seven domains: concerns about epileptic seizures, emotional aspects, vitality, sociability, adverse effects of antiepileptic drugs (AEDs), cognitive aspects, and global quality of life. The overall score and the score for each domain ranged from 0 to 100, with a higher

score indicating a better quality of life [21].

Functioning was evaluated using the Functional Independence Measure (FIM), which assesses motor and cognitive tasks in daily life. Each question is rated on a scale from 1 (total dependence) to 7 (total independence), resulting in an overall score between 18 and 126 points. A higher score indicated greater independence and less need for assistance when completing the activities [22];

The adverse effects of antiseizure medications were assessed using the Liverpool Adverse Events Profile (LAEP), which includes 19 items divided into a four-point Likert scale: (1) never a problem, (2) rarely a problem, (3) sometimes a problem, and (4) always a problem. Scores range from 19 to 76 points, with higher scores indicating more adverse effects caused by the medications [23].

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), which is divided into seven sections: (1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep changes, (6) use of sleeping medications, and (7) daytime dysfunction. The score for each item ranged from 0 to 3 points, with the total score ranging from 0 to 21. Scores between 0 and 4 indicate good sleep quality, scores between 5 and 10 indicate poor sleep quality, and scores above 10 indicate a sleep disorder [24].

The Gross Motor Function Classification System (GMFCS) and Manual Ability Classification System (MACS) were applied to classify the gross motor function and manual ability of participants with CP overlapping according to the degree of motor impairment. Both systems are divided into age groups of up to 18 years and consist of five levels. The lower the classification level, the greater the independence and the lower the motor impairment and difficulty in performing manual activities [25,26]. The level of support was classified for participants with ASD; the lower the support level, the greater the independence [27].

Seizure frequency was continuously monitored in participants over a 36-week period, in accordance with the caregivers' reports. Baseline data representing the number of seizure episodes recorded during the 12 weeks prior to the initiation of EAT were used as references for subsequent comparisons. Interim reports of the data were collected at regular intervals every 12 weeks (Baseline, 12 weeks, 24 weeks, and 36 weeks) to assess progress and make the necessary adjustments to the monitoring protocol.

## 2.8. Horse-related data

The Horse Welfare Assessment Protocol (HWAP) was used to ensure the efficacy of interventions in EAT and to comprehensively assess the living conditions of the animals involved. This protocol examines four main indicators (nutrition, comfort, health, and behavior) and is divided into five levels: very low, low, regular, high, and very high [28].

## 2.9. Evaluation points

A total of 36 weekly EAT sessions were conducted, while data were collected at four assessment points: baseline (T1) and after 12 (T2), 24 (T3), and 36 (T4) sessions of the EAT intervention. This longitudinal approach allowed for a comprehensive examination of the effects of the intervention over time, providing insights into both short- and medium-term outcomes. The structured assessment schedule at key intervals enabled a thorough evaluation of participants' progress, as well as the impact of the EAT intervention at different stages of its implementation.

Potential confounders related to epilepsy include the severity of epilepsy symptoms, frequency of seizures, differences in medication regimens and adherence, changes in medications during protocols, and other health conditions beyond epilepsy. Potential confounders outside of epilepsy include disparities in socioeconomic status; previous experience with horses among participants; therapeutic alliances between participants, therapists, and horses; external stressors in participants' lives; cognitive abilities; and support from family or caregivers. Addressing these potential confounders through study design, statistical

analysis, or subgroup analysis could enhance the validity and reliability of study findings in terms of the effectiveness of EAT in PWE.

## 2.10. Statistical methods

In this study, statistical analysis focused on several outcomes to evaluate the efficacy of EAT on PWE: QOLIE-31, FIM, LAEP, PSQI, and number of seizure episodes. For descriptive analysis, the data were expressed as the medians and quartiles (25 %–75 %). The Friedman test was used to assess differences in outcome measures over time, followed by Conover's post hoc test with Holm's correction to control for multiple comparisons. This method was selected to provide a robust analysis of the repeated-measures data, and prevent the increased likelihood of Type I errors from multiple comparisons. A level of 5 % was considered statistically significant. Data were analyzed using the JASP software version 0.13 (JASP Team, Amsterdam, Netherlands).

## 3. Results

### 3.1. Recruitment and selection of participants

Of the 180 participants enrolled in the CLE, 166 were excluded because they had clinical conditions other than epilepsy such as ASD, CP, Down syndrome, rare syndromes (Moebius, West, Ehlers-Danlos, and Seckel syndromes), attention deficit hyperactivity disorder, hydrocephalus, myelomeningocele, or microcephaly. Finally, 22 eligible participants were identified. However, upon further review of the eligibility criteria, five participants were excluded because they declined to participate. This resulted in a final group of 17 participants who met all inclusion criteria. However, three participants were excluded from the analysis because they withdrew from the intervention. Therefore, 14 participants completed the study (See details in Fig. 1).

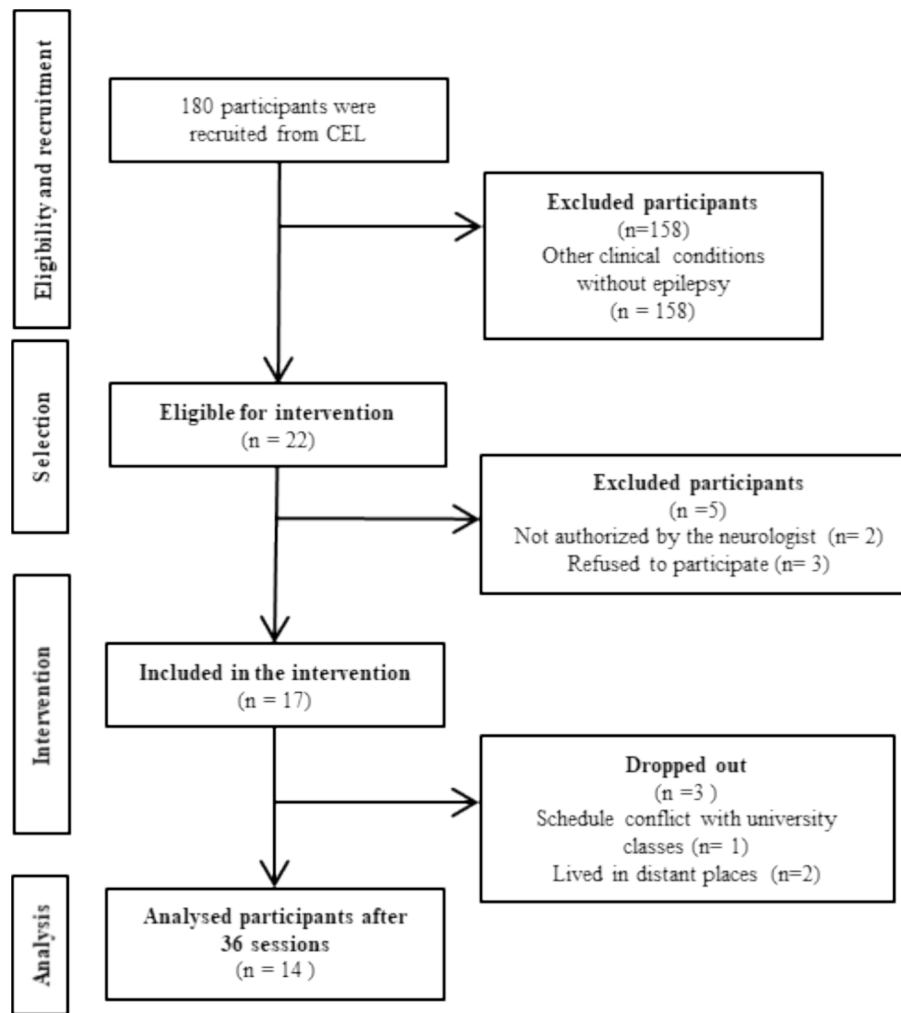
### 3.2. Participant characteristics

The findings were non-normally distributed and were, therefore, presented as percentages, medians, and interquartile range (25–75 %). Of the 14 PWE, 13 had epilepsy associated with other neurological conditions; six (42.86 %) had epilepsy + CP; two (14.29 %) had epilepsy + hydrocephalus; three (21.43 %) had epilepsy + ASD; one (7.14 %) had epilepsy + CP+ASD+hydrocephalus; one (7.14 %) had epilepsy + nonspecific congenital malformation of the nervous system + lumbar spina bifida with hydrocephalus, and one (7.14 %) had only epilepsy. Among participants with CP linked to epilepsy, one (7.14 %) was classified as level II on the GMFCS, and five (35.71 %) were classified as level V. In terms of fine motor function, they were classified as follows: one each (7.14 %) as level I, II, and IV, and three (21.43 %) as level V. It was not possible to classify the fine and gross motor functions of eight (57.15 %) participants as they were over 18 years old or had another clinical condition. Regarding the assistive devices used by these participants, five (83.3 %) used a wheelchair as an assistive device, while one (16.7 %) did not use any. The age at the first seizure was 12 (6–54) months, while the diagnosis was made at 36 (12–72) months. Additionally, 71 % of the participants used antiseizure medications.

The median age of the participants was 12.5 years; 71 % were male. The participants' levels of educational attainment varied, with 21 % having a high school education, and 14 % having no primary school education. Most participants attended public institutions (79 %). In total, 44 % of parents or caregivers had incomplete primary education, while 21 % had completed secondary education (21 %). The monthly income of most participants was between one and two Brazilian minimum wages (86 %). Sociodemographic data are shown in Table 1.

### 3.3. Quality of life and functioning

The results (Table 2) provide a comprehensive overview of how EAT



**Fig. 1.** Flowchart of recruitment and selection of participants for the study. Abbreviations: CLE- *Centro Largentense de Equoterapia*. The EAT had a positive impact ( $p = 0.014$ ) on the Adverse Events Profile in PWE. After post hoc testing, a statistically significant improvement was only observed between 24 and 36 weeks ( $p = 0.034$ ). There was no significant difference at other times (baseline x 12 weeks:  $p = 1.00$ ; baseline x 24 weeks:  $p = 1.00$ ; baseline x 36 weeks:  $p = 0.118$ ; 12 weeks x 24 weeks:  $p = 1.00$ ; 12 weeks x 36 weeks:  $p = 0.137$ ).

affects PWE in terms of function and QoL. Over the 36-week period, improvements were observed in several domains, including significant changes in the overall scores for functional independence ( $p < 0.001$ ) and QoL ( $p = 0.002$ ).

Differences across the four time points for the QOLIE-31 overall score were significant ( $p = 0.002$ ); post hoc comparisons indicated significant differences between baseline and 12 weeks ( $p = 0.034$ ), between baseline and 24 weeks ( $p = 0.003$ ), and between baseline and 36 weeks ( $p = 0.002$ ). The social functioning domain further showed differences ( $p = 0.031$ ) throughout the study, with post hoc tests indicating differences between baseline and 12 weeks ( $p = 0.008$ ), and between baseline and 36 weeks ( $p = 0.03$ ). The cognitive functioning domain further revealed significant differences ( $p = 0.019$ ) throughout the study, with post hoc tests indicating significant differences between baseline and 36 weeks ( $p = 0.014$ ), and 12 weeks and 36 weeks ( $p = 0.010$ ). The overall QoL domain further showed differences ( $p = 0.012$ ) throughout the study, with post hoc tests indicating differences between baseline and 24 weeks ( $p = 0.022$ ) and between baseline and 36 weeks ( $p = 0.003$ ) (Table 2).

Overall, we found significant differences in the overall FIM scores across the four time points ( $p < 0.001$ ). Post hoc comparisons revealed significant differences between baseline and 24 weeks ( $p = 0.013$ ), and between baseline and 36 weeks ( $p = 0.04$ ). Participants further showed substantial improvements in their ability to complete self-care tasks ( $p = 0.001$ ), with post hoc tests indicating differences between baseline

and 24 weeks ( $p = 0.013$ ), and between baseline and 36 weeks ( $p = 0.006$ ). The results for cognitive function over the 36-week period were significant ( $p = 0.021$ ); however, Conover's post hoc test with Holm correction did not show significant differences in this domain over time (Table 2).

#### 3.4. Adverse effects of antiseizure medications and sleep quality

The box plots in Figs. 2 and 3 represent the results of the LAEP and PSQI scores measured at baseline and at 12-, 24-, and 36-week intervals. The results showed that the EAT had a positive effect at 36 weeks ( $P=0.019$ ). Conover's post hoc test further revealed fluctuations in the initial LAEP time points, with only the time point between 24 and 36 weeks showing statistical significance ( $p = 0.034$ ) (Fig. 2). Furthermore, EAT had a positive effect on sleep quality at 36 weeks ( $P=0.014$ ). In Conover's post hoc test, significant changes in PSQI scores were observed between 24 and 36 weeks ( $P=0.041$ ) (Fig. 3).

#### 3.5. Frequency of seizures

Fig. 4 shows the total number of seizure episodes per week, as well as the median number of seizure episodes per participant at specified intervals (baseline and at 12, 24, and 36 weeks). The median values were 2 (range 0–4) at baseline, 1 (range 0–3) during the first 12 weeks, 0 (range

**Table 1**  
Description of the participants' sociodemographic data.

Data	Median Q1-Q3 (25–75 %)
Age (years)	12.5 (38–39.75)
BMI (kg/cm <sup>2</sup> )	18.43 (15.65–22.22)
Birth weight (kg)	3.280 (3.060–3.450)
Mother's age at participant's birth	25 (22–29)
Mother's gestation weeks	39 (38–39.75)
Age at first crisis (months)	12 (6–54)
Age at diagnosis (months)	36 (12–72)
	N (%)
<b>Sex</b>	
Girls	4 (29)
Boys	10 (71)
<b>CID</b>	
G40	1 (7)
G40 + G80	6 (44)
G40 + G91	2 (14)
G40 + G80 + G81 + F84	1 (7)
G40 + Q07.9 + Q05.2	1 (7)
G40 + F84	3 (21)
<b>Gross Motor Function Classification System</b>	
Level I	0 (0)
Level II	1(7)
Level III	0 (0)
Level IV	0 (0)
Level V	5 (36)
Not applicable	8 (57)
<b>Manual Ability Classification System</b>	
Level I	1(7)
Level II	1(7)
Level III	0 (0)
Level IV	1 (7)
Level V	3 (21)
Not applicable	8 (58)
<b>Autism Spectrum Disorder (ASD): degree of dependence and/or need for support</b>	
Level I	2 (14)
Level II	1 (7)
Level III	1 (7)
Not applicable	10 (72)
<b>Drugs and medications</b>	
Anti-seizure	15 (71)
Antipsychotic	1 (5)
Muscle relaxant	1 (5)
Sleep inducers	1 (5)
Antidepressants	1 (5)
Anxiolytics	2(9)
<b>Mother's type of birth</b>	
Natural	7 (50)
Cesarean	7 (50)
<b>Participants' education</b>	
Not study	2 (14)
Elementary school	5 (36)
Middle school	3 (21)
Incomplete high school	1 (7)
Complete high school	3 (21)
<b>Type of educational institution</b>	
Public	11 (79)
Private	1 (7)
Do not study	2 (14)
<b>Education of parents or caregivers</b>	
Incomplete elementary and middle school	6 (44)
Complete elementary and middle school	0 (0)
Incomplete high school	2 (14)
Complete high school	3 (21)

**Table 1 (continued)**

Data	Median Q1-Q3 (25–75 %)
Incomplete higher education	0
Complete higher education	3 (21)
<b>Monthly income</b>	
< 1 minimum wage	0
1 a 2 minimum wage	12 (86)
2 a 3 minimum wage	0
3 a 4 minimum wage	2 (14)
<b>Pavement on the street of the residence</b>	
Yes	12 (86)
No	2 (14)
<b>Basic sanitation (sewage network)</b>	
Yes	8 (57)
No	6 (43)
<b>Garbage collection</b>	
Yes	13 (93)
No	1 (7)

Abbreviations. N=number, %= percentage, BMI=body mass index.

0–0) from the 13th to the 24th week, and 0 (range 0–1) from the 25th to 36th week. Statistical analysis confirmed significant reductions in seizure frequency compared with baseline, starting from the 13th week. This decrease was statistically significant at the 13th to 24th week interval ( $p < 0.001$ ) and was maintained throughout the 25th to 36th weeks ( $p = 0.002$ ). Non-epileptic seizures were also investigated. According to medical records, none of the patients experienced non-epileptic seizures. However, even when the diagnosis of epilepsy was made by a clinician with appropriate expertise, some cases of non-epileptic seizures may inevitably be missed.

### 3.6. Horse results

Seven horses (2 male and 5 female) selected for this study underwent welfare evaluation. The horses ranged in age from 12 to 27 years and represented a variety of breeds: 29 %, undefined; 29 %, *Mangalarga* crossbreeds; 29 %, quarter horses, and 13 %, *Mangalarga*. The coat color distribution was as follows: 14 % bay, 43 % grey, 29 % brown, and 14 % gated. These horses worked an average of five hours a week. The most common gaits observed were walking, trotting, and galloping, with 85.71 % exhibiting these gaits, except for one horse that performed steps, marching, and galloping. Regarding animal welfare, the comfort, health, and behavior of the horses were monitored. All horses had access to a stable shelter, shade, a comfortable resting surface, space to run short distances, and a clean environment. They also displayed appropriate behaviors for the activities in which they were engaged.

## 4. Discussion

From an initial group of 180, only 14 participants completed the study protocol. Most participants had epilepsy linked to other neurological conditions, with a median age of 12.5 years, were predominantly of the male sex, and attended public institutions. Parents or caregivers often had low levels of education, and most participants' families had an income between one and two Brazilian minimum wages. Throughout the 36-week study period, significant improvements were noted in QoL and functioning, particularly in self-care abilities and social cognition. The adverse effects of anti-seizure medications showed some fluctuations; however, the overall improvement in sleep quality was positive during the study. Seizure frequency among the participants had decreased significantly at the 24- and 36-week marks compared to the baseline. This study also involved seven horses of various breeds that

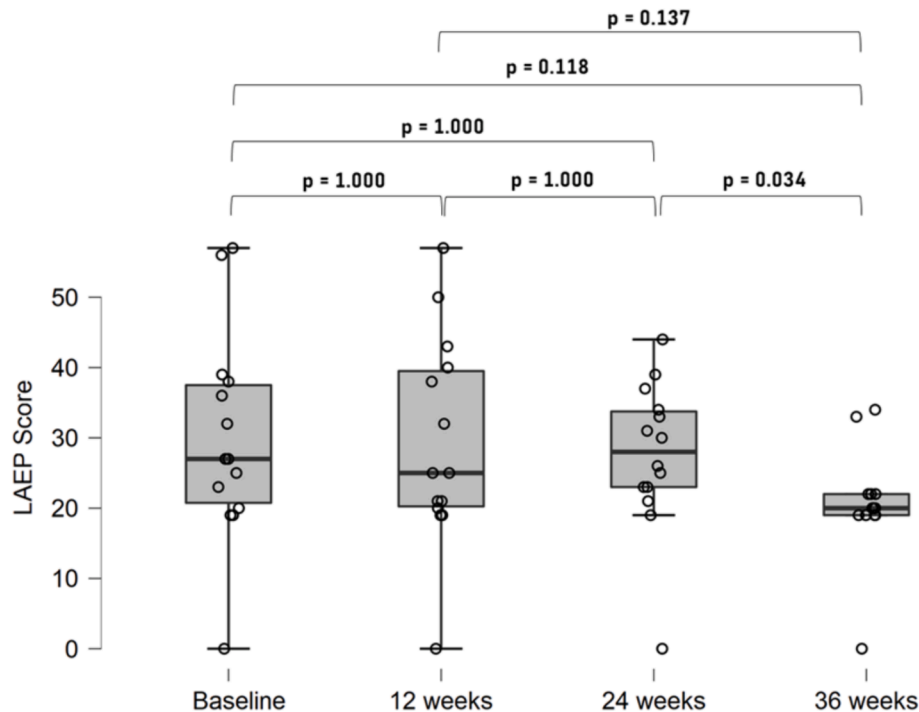
**Table 2**

Changes in quality of life and functional independence over time in PWE undergoing 36 weeks equine-assisted therapy.

Measurements	Baseline	12 weeks	24 weeks	36 weeks	p-value
<b>Quality of Life in Epilepsy Inventory (QoLIE-31)</b>					
Seizure worry	38.30 (17.75 – 74.66)	47.33 (20.00 – 95.00)	58.50 (46.50 – 67.25)	62.50 (41.25 – 75.25)	0.306
Emotional well-being	78.0 (54.0 – 83.00)	72.00 (56.0 – 83.00)	76.0 (61.0 – 87.00)	84.0 (68.0 – 92.00)	0.150
Energy/fatigue	72.50 (65.0 – 83.75)	82.5 (65.0 – 90.00)	82.5 (75.0 – 90.00)	72.50 (70.0 – 90.00)	0.498
Social functioning	65.00 (60.00 – 69.75) <sup>(G)</sup>	80.00 (67.50 – 88.00) <sup>(H)</sup>	91.50 (80.00 – 100.0)	95.00 (77.75 – 100.0) <sup>(I)</sup>	0.031***
Medication effects	75.00 (37.50 – 97.91)	66.66 (27.08 – 97.30)	91.66 (66.66 – 91.66)	79.16 (52.08 – 91.66)	0.736
Cognitive functioning	59.02 (54.09 – 66.66) <sup>(A)</sup>	61.66 (48.33 – 67.91) <sup>(B)</sup>	75.41 (58.54 – 90.00)	71.66 (54.79 – 90.83) <sup>(C)</sup>	0.019*
Overall quality of life	67.50 (55.00– 77.50) <sup>(D)</sup>	76.25 (63.12–97.50)	83.75 (80.62– 89.37) <sup>(E)</sup>	80.00 (72.5 – 95.00) <sup>(F)</sup>	0.012**
Overall score	62.18 (57.88 – 70.25) <sup>(J)</sup>	71.23 (62.72 – 75.77) <sup>(K)</sup>	75.15 (67.17 – 83.75) <sup>(L)</sup>	80.18 (65.30 – 86.78) <sup>(M)</sup>	0.002****
<b>Functional Independence Measure (FIM)</b>					
Self-care	18.00 (8.25 – 25.75) <sup>(N)</sup>	19.00 (11.00 – 32.00)	20.00 (12.00 – 34.00) <sup>(O)</sup>	21.00 (10.75 – 39.25) <sup>(P)</sup>	0.001*****
Sphincter control	10.00 (2.00 – 14.00)	10.50 (2.00 – 14.00)	13.00 (2.25 – 14.00)	14.00 (2.00 – 14.00)	0.290
Mobility	6.00 (3.00 – 21.00)	10.5 (3.00 – 21.00)	10.00 (3.00 – 21.00)	11.00 (3.00 – 21.00)	0.846
Locomotion	5.50 (2.00 – 10.75)	6.50 (2.25 – 11.75)	6.00 (2.00 – 12.00)	6.00 (2.00 – 12.75)	0.191
Communication	12.50 (10.00 – 14.00)	13.00 (11.25 – 14.00)	14.00 (11.25 – 14.00)	14.00 (12.00 – 14.00)	0.080
Social cognition	15.00 (11.25 – 17.00)	14.00 (12.00 – 15.00)	15.00 (15.00 – 17.75)	15.00 (13.5 – 18.75)	0.021 <sup>‡</sup>
Overall score	70.00 (36.50 – 97.75) <sup>(Q)</sup>	69.50 (49.25 – 97.75)	72.50 (51.00 – 110.25) <sup>(R)</sup>	70.00 (51.75 – 116.75) <sup>(S)</sup>	<0.001*****

Data are presented as median and interquartile range (Q1 – Q3).

‡ Despite the Friedman test resulting in a p-value < 0.05, Conover’s post-test with Holm correction did not show significant differences in this domain over time. \*(A) x (C): p = 0.014; (B) x (C): p = 0.010. \*\*(D) x (E): p = 0.022; (D) x (F): p = 0.003. \*\*\* (G) x (H): p = 0.008; (G) x (I): p = 0.03; \*\*\*\*(J) x (K): p = 0.034; (J) x (L): p = 0.003; (J) x (M): p = 0.002. \*\*\*\*\* (N) x (O): p = 0.013; (N) x (P): p = 0.006. \*\*\*\*\* (Q) x (R): p = 0.013; (Q) x (S): p = 0.004.



**Fig. 2. Longitudinal assessment of adverse events profile over time in PWE undergoing 36 weeks equine-assisted therapy.** The EAT had a positive impact (p = 0.014) on the sleep quality of PWE. After post hoc testing, a significant improvement was only observed between 12 and 36 weeks (p = 0.041). There was no significant difference at other times (baseline x 12 weeks: p = 0.828; baseline x 24 weeks: p = 0.424; baseline x 36 weeks: p = 0.126; 12 weeks x 24 weeks: p = 0.198; 24 weeks x 36 weeks: p = 0.828).

participated in the EAT, and whose welfare was continually monitored to ensure that they were living and working in good conditions.

**4.1. Quality of life and functioning**

Impaired QoL and functioning are commonly observed in PWE [29]. Issues such as motor control and dysfunction in functional independence, lifestyle changes, cognitive problems, and social restrictions are common. Several factors can contribute to the decline in both physical and mental health-related QoL. For example, the adverse effects of anti-

seizure medications, mental health issues such as depression and anxiety, and other psychosocial factors can all have a significant impact in this regard [30]. Our understanding of this issue is based largely on cross-sectional studies conducted in specific geographical areas. This study was conducted in a low-income region, which could have had a considerable impact. After thirty-six weeks of EAT intervention, improvements were observed in several domains of cognitive function and QoL, although no significant differences were observed in emotional well-being, energy levels, social interactions, mobility, locomotion, or communication. While some domains did not show any significant

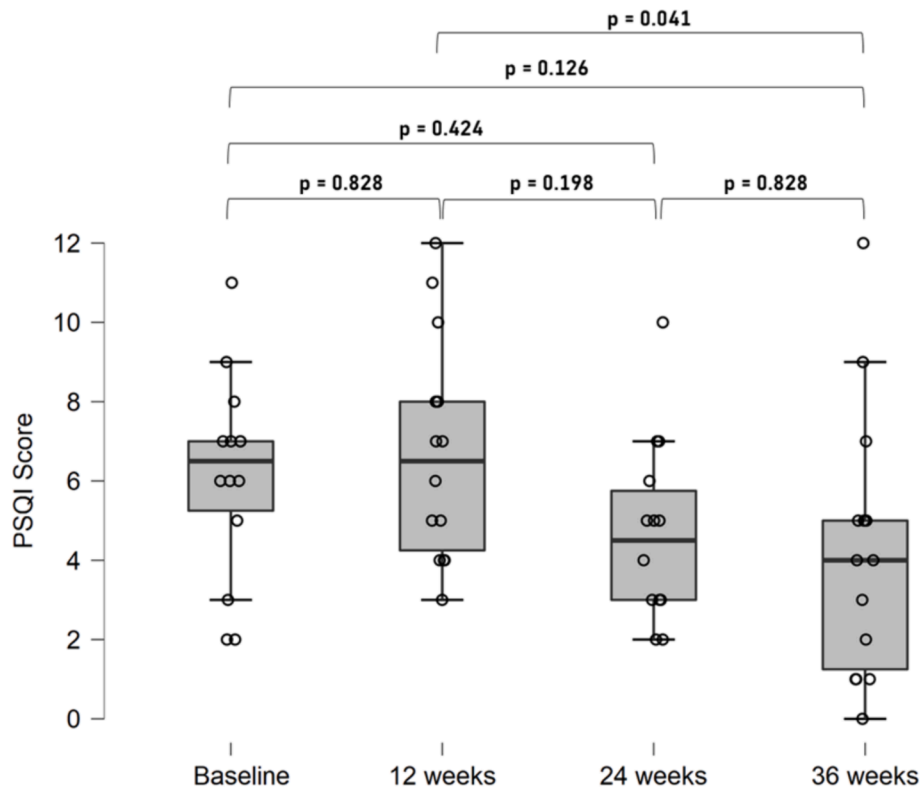


Fig. 3. Values of sleep quality over time in PWE undergoing 36 weeks equine-assisted therapy.

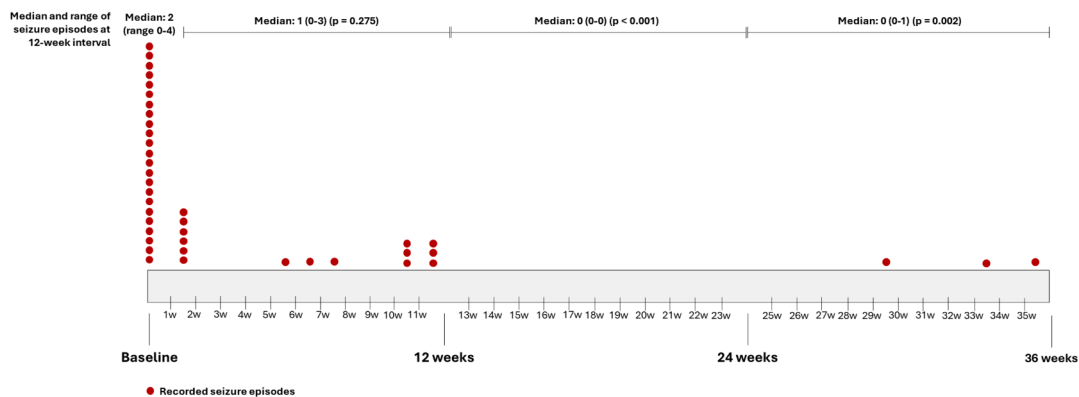


Fig. 4. Progression of Seizure Episodes in Epilepsy Patients Over 36 Weeks of Equine Therapy.

changes, this aligns with findings from studies reporting improvements in QoL in individuals with other neurological conditions [16,31].

#### 4.2. Frequency of seizures

Another important issue that needs to be addressed is the beneficial effects of EAT on seizure frequency. A significant decrease in the number of seizure episodes was noted following EAT practice compared to baseline. No seizures were observed after 24 sessions, while only a few seizures were reported after 36 sessions. Various physical interventions can induce positive results in PWE. Both clinical and experimental studies have indicated that regular physical exercise can have a positive effect on seizure frequency. Studies in humans have further reported that participation in aerobic exercise programs either reduces [32,33] or does not increase seizure occurrence [34,35]. Similarly, in animal models of epilepsy, improvements have been observed under chronic conditions [36]. Participation in physical activity can have beneficial

effects during different periods of life. This study involved PWE across various age groups. While the beneficial influence of exercise on seizure frequency in adults has been frequently reported, its benefits in children and adolescents have been less well investigated [37].

In this study, 9 out of 14 PWE were children or adolescents. All participants showed a decrease in seizure frequency at the end of the intervention period. No seizures were observed during horseback riding. To the best of our knowledge, only one study has previously reported the influence of EAT on seizure frequency [38]. In this prior study, Deutz et al. [38] reported the effects of the EAT on gross motor function and QoL in children with bilateral spastic CP and observed that among 35 children who completed the protocol, only two had seizures during the study period.

During physical activities, various brain structures beyond those directly involved in motor function are activated, including attention, vigilance, sensory stimulus processing, and visuospatial abilities [36,37]. The increased sensory input to the brain and the elevated

vigilance and attention required during exercise may all contribute to the decrease in seizures observed in PWE [39]. This idea is supported by a study from the 1970s that found that epileptiform activity was more common during relaxation periods, such as sitting with eyes closed, and decreased during stimulating activities, such as participating in dramatic performances [40]. In addition to controlling seizures, we suggest that engaging in leisure activities or social sports can enhance children's sense of community connections.

#### 4.3. Adverse effects of antiseizure medications and sleep quality

The side effects of anti-seizure medications can have a significant impact on QoL, regardless of the seizure outcome [41]. Previous studies involving young people have shown that psychiatric and behavioral side effects are most commonly reported in children and adolescents prescribed anti-seizure medications [42]. Psychiatric side effects include depression, psychosis, and anxiety, whereas behavioral side effects include irritability, anger, aggression, and changes in emotion and mood [43]. As the study progressed, it became evident that these effects decreased over time, with a significant change ( $p = 0.034$ ) observed between 24 and 36 weeks, indicating a potential improvement in tolerability or a reduction in adverse effects with the EAT intervention. We further observed an improvement in the PSQI score from 24 to 36 weeks of the EAT protocol, indicating better sleep quality towards the end of the study. Antiseizure medications may affect the quality of sleep in PWE, leading to sleep disorders such as insomnia, sleep apnea, and excessive daytime sleepiness [44].

Lawthom et al. [45] previously highlighted the impact of epilepsy and anti-seizure medications on the sleep quality of PWE, thereby affecting their overall well-being. Concerning physical activity, the literature has documented significant findings that support the effectiveness of regular physical exercise as an intervention for improving poor sleep quality across various age groups, including children [46], adolescents [47], and adults [48]. In the case of epilepsy, Talo & Turan [49] reported that exercise practice had positive effects on sleep quality. Additionally, muscle relaxation exercises have been found to reduce the severity of depressive symptoms and the quality of life in PWE.

Children with epilepsy who maintained levels of activity similar to their peers without epilepsy showed good objective measures of sleep, despite parent-reported sleep problems [50]. Accordingly, women with refractory epilepsy who engaged in exercise programs reported experiencing fewer sleep problems [51]. Similarly, in experiments using animal models of epilepsy, de Lima et al. [52] observed a significant impact of acute exercise on the sleep patterns of animals with temporal lobe epilepsy. An increase in total sleep time and slow-wave sleep, accompanied by a decrease in wakefulness, has further been noted in exercised animals with epilepsy [52]. Considering this scenario, PWE should be encouraged to adopt healthier lifestyles, including engaging in physical activity, to help manage factors associated with this condition.

#### 4.4. Limitations

While our study has provided valuable insights into EAT practices by PWE, it is essential to acknowledge and address its potential limitations. The small sample size of 14 participants, and the fact that participants only underwent one session per week, may have limited the generalizability of our findings. As socioeconomic status strongly influences QoL, research that includes families with diverse socioeconomic backgrounds should be conducted. The heterogeneity of the participant groups, involving individuals with various clinical conditions, makes it challenging to determine specific therapeutic effects. Additionally, the absence of a control group restricts the possibility of establishing causal relationships between the EAT and the observed outcomes. As such, certain factors that could potentially affect the interpretation of our findings include the participants' seizure frequency per week or month, their baseline seizure-free status, and the type of epilepsy they may

exhibit.

The selection bias due to the inclusion of participants already undergoing the intervention potentially limits the generalizability of the findings to a broader population of PWE. The confounding bias may also be influenced by the range of health conditions present in patients with epilepsy, which can complicate the identification of specific therapeutic effects. It is challenging to determine whether these effects are solely due to the intervention being studied, which would affect the validity of the results. Therefore, long-term interventions are necessary to achieve better outcomes.

## 5. Conclusions

In the context of epilepsy care, there is a significant gap in the scientific literature, with limited exploration of the potential of the EAT as an intervention for QoL and functioning in PWE. By addressing this research gap, this study provides valuable insights into the potential benefits of EAT as a transformative therapeutic approach for PWE, fostering permanent changes in lives and human-horse interactions. Overall, our study demonstrated the positive therapeutic effect of EAT on several aspects of epilepsy, including cognitive function, sleep quality, QoL, self-care tasks, and seizure frequency.

### Ethical statement

All procedures were performed in compliance with relevant laws and institutional guidelines and have been approved by the appropriate institutional committee. Ethics Committee of Human Research by number 5.685.082. All participants and parents/caregivers assigned informed consent before protocol intervention.

### CRediT authorship contribution statement

**Franciely Oliveira de Andrade Santos:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Data curation. **Caroline Souza-Santos:** Methodology, Investigation, Data curation. **Adrielle Andrade Passos:** Writing – review & editing, Visualization, Validation. **Roseane Nunes de Santana Campos:** Methodology. **Paulo Ricardo Martins-Filho:** Software, Resources, Funding acquisition, Formal analysis. **Ricardo Mario Arida:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Funding acquisition, Conceptualization. **Lavínia Teixeira-Machado:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ebr.2024.100707>.



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