Understanding the Effects of Therapeutic Horseback Riding on Functional and Behavioral Outcome in Autistic Children and Adolescents

Leigh-Anne McCormick
University of Lynchburg, mccorml847@lynchburg.edu

Understanding the Effects of Therapeutic Horseback Riding on Functional and Behavioral Outcome in Autistic Children and Adolescents

Leigh-Anne McCormick

Senior Honors Project

Submitted in partial fulfillment of the graduation requirements of the Westover Honors Program

Westover Honors Program

May, 2022

Jeffrey Herrick, PhD

Ei Hlaing, PhD

Christine Terry, PhD

Abstract

Equine-assisted services (EAS) have been shown to provide a stimulatory environment that can improve functional motor skills and emotional well-being in individuals with autism spectrum disorder (ASD).

Purpose: The aim of this study was to show the effects of an 8 week therapeutic horseback riding (THR) program on the core strength, balance, and emotional regulation in children and adolescents with and without ASD.

Methods: Six individuals with ASD and six individuals without ASD were previously enrolled in a therapeutic riding program and were observed and tested for changes in functional abilities, including core strength, balance, and emotion regulation at weeks 1, 4, and 8.

Results: Variable means increased for each test across both groups, though the increases were not statistically significant. The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA) average improvement scores from baseline to week 8 were significantly different between the experimental and control groups, and 30 second chair stand average improvement scores for the control group between the first 4 weeks and the full 8 weeks were significantly different.

Conclusion: While there were improvements in every variable outcome, the mean differences were not enough to be significant, leading us to conclude that 8 weeks of THR is not sufficient to provide significant increases in core strength, balance, and emotion regulation.

Key Words: autism spectrum disorder, therapeutic horseback riding, equine-assisted services, children, adolescents

Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that has a range of symptoms, which can present differently for each person. The primary symptoms of ASD include impairments in social and communication skills as well as distinct, repetitive behaviors (Zoccante et al., 2021). In addition, individuals with ASD often present with physical impairments that alter their motor function, including loss of strength, balance, flexibility, and coordination (Srinivasan et al., 2018). Researchers have estimated that 1 out of every 160 children across the world have ASD (Elsabbagh et al., 2012). As such, it is largely understood that ASD has a complex pathophysiology with a high level of symptom variability.

Common treatments for ASD focus on behavioral and physical modifications. The most common treatment for ASD is behavioral therapy. Medications have also been researched for the potential to help individuals with ASD to manage their symptoms, but no “cure” for ASD has been found. Risperidone and aripiprazole are currently the only drugs approved to be given to youth with ASD with the aim to specifically limit symptoms of ASD, and it is recommended for the medication to be paired with behavioral therapy (LeClerc & Easley, 2015). Because of the multiple factors leading to and affecting ASD, a single treatment style is not likely to address the complex interaction of behavioral and physical symptoms. Instead, a treatment approach that includes multiple modes of intervention may be more effective in helping individuals with ASD to progress in their abilities (Zoccante et al., 2021).

Equine-assisted services (EAS) are emerging treatments that have been administered to children with ASD. Equine-assisted services is an umbrella phrase that encompasses many types of services which utilize horses (equines) to bring a benefit to people. Equine-assisted learning (EAL) is implemented by qualified professionals who use human-horse interactions, activities on and off the horse, and a stimulating equine environment to help people of all ages improve their leadership skills, their academic skills, and their social skills. Therapeutic horseback riding (THR) utilizes a horseback riding instructor to improve social, cognitive, and physical abilities of the rider. THR differs from hippotherapy and equine therapy (ET) as a licensed physical, occupational, and or speech therapist is needed in order to conduct hippotherapy or ET lessons (Wood et al., 2021). Horseback riding to improve overground function is supported, as it provides the rider with similar muscular stimulation to that of walking, along with similar stimulation for improving strength, balance, and flexibility, in addition to enjoyment of recreational activities (Garner & Rigby, 2015; Zoccante et al., 2021).

A few studies have reported emotional and physical benefits from therapeutic horseback riding, such as improvements in social communication, motor function, and movement coordination (Srinivasan et al., 2018; Zoccante et al., 2021). One case study showed hippotherapy as an effective option in the treatment of a young child with hemiplegia, or paralysis of one side of the body following a stroke. In the case report study, the patient showed an improvement in endurance, seated posture, and the ability to have independence through daily activities after participating in six weekly sessions with each session lasting 30 minutes (Schug, 2018). Another study found hippotherapy to be a suitable option in the treatment of children with cerebral palsy by improving their gross motor skills and functional performance measures. The subjects for that study participated in eight weeks of hippotherapy, where they had 45 minute sessions twice a week (Park et al., 2014). One randomized controlled trial showed that THR can positively affect social and communication behaviors, limit irritability, and decrease hyperactivity in a population of autistic children and adolescents after 10 weeks of 45 minute sessions (Gabriels et al., 2015). However, there are many limitations in these studies that may restrict our understanding of the complete benefits of THR. A few of these limitations are a small sample size, lack of consistency in outcome measures, and very few comparisons to control groups (Srinivasan et al., 2018). In addition, there is limited research on how physical and emotional improvements from therapeutic horseback riding translate to functional skills outside of horseback riding.

Therefore, the purpose of this study was to determine the effects of 8 weeks of a therapeutic horseback riding program on equine riding performance and emotional regulation, and understand how therapeutic horseback riding affects overground performance: specifically dynamic stability and mobility. We hypothesized that the therapeutic horseback riding program would help the individuals to improve their riding performance, increase emotional regulation, and help to improve skills that will translate into everyday activities of living.

Methods

Experimental Design

We used a quasi-experimental, cross sectional design in which we included 12 children and adolescents who were already in an existing therapeutic riding program over an 8 week period, and implemented functional and behavioral tests to report changes over the 8 weeks between an experimental group (autistic group) and a control group (non-autistic group). Measurements were collected at baseline, week 4, and week 8.

Recruitment

The parents or guardians of each participant received a letter describing the research and asking them to meet with the researchers. The purpose of the meeting is to discuss the risks and benefits and to give them a chance to ask any questions that they may have. A parent of each participant was also given a consent form which explained the purpose of the study as well as the research plan. After obtaining parental consent, assent scripts were then read aloud to each participant, followed by the researcher asking if the participant wanted to be a part of the study. If the participant said “yes,” a witness signature was obtained as proof of assent.

Participants

This study was approved by the Institutional Review Board (IRB) at the University of Lynchburg, and given an approval number of LHS2122034. Participants in this study were recruited from different pre-existing riding programs at Brook Hill Farm in Forest, Virginia. Brook Hill Farm is certified as a Professional Association of Therapeutic Horsemanship (PATH) International organization, which means that the standards for ethics and safety of each individual and animal involved in the program are upheld to the highest degree (Gabriels et al., 2015). Participants in the testing group were recruited from a therapeutic riding program at Brook Hill Farm called the Rockin’ Riders program. The criteria to participate in this testing group included that individuals were from the ages of 6-17, had been diagnosed with ASD, and were currently a part of Brook Hill Farm programming. The control group (non-autistic) was recruited through the United Neigh program, the Saddle Up club, and the Gaits for Change program at Brook Hill Farm, which are riding programs for youth of ages 6 through 18. All participants were already actively enrolled in and participating in their specific program. Parental consent and participant assent were both obtained prior to any data collection. The experimental group included three females and three males, while the control group included five females and one male. The demographics for both groups are shown in Table 1.

Procedures

The eight week therapeutic horseback riding study was performed at Brook Hill Farm between January and April of 2022. The individuals simply continued their normal therapy session dates and times, and participated in the therapeutic activities as prescribed by each program. Each participant in the Rockin' Riders program (autistic group) continued to attend their once weekly hour-long therapy sessions. Therapy sessions consisted of the participant helping to groom and tack their horse, riding the horse during the lesson, and then helping to un-tack and groom their horse again. Each participant had a schedule of responsibilities that is unique to their own individual abilities and needs, as determined by the riding instructor. Four of the six participants in the control group continued their once weekly, hour long riding sessions, while the remaining two participants in the control group continued their four lessons per week, each lasting roughly an hour. Data collection occurred on the first, fourth, and eighth week of the study.

Outcome Measures

Emotional regulation was assessed by the participant's parents who were asked to fill out the Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA). This questionnaire is an adapted version of the Emotion Regulation Questionnaire (ERQ), which was targeted toward adult populations. The questionnaire assessed cognitive reappraisal (CR) and expressive suppression (ES) through 10 questions that were asked to determine emotion regulation (ER) (Gullone & Taffe, 2011). These questions are shown in Figure 1.

Dynamic stability and core strength integrated measurements were taken through three overground tests: the 30 second chair stand and the timed up and go mobility assessments, and the four square step test to assess dynamic stability. The 30 second chair stand test consisted of the participant sitting and standing as many times as possible in 30 seconds. The timed up and go was measured by the participant standing up out of a chair and walking around a cone which was placed three meters (10 feet) away, and then returning to the chair as quickly as possible. The four square dynamic stability test utilized two lines on the ground which made a cross shape and created four boxes which were numbered 1-4. The participants were asked to to stand in box 1 facing box 2 and perform the following movement in relation to the 4 boxes: step forward to box 2, step to the right to box 3, step backwards to box 4, step to the left to box 1, step to the right to box 4, step forward to box 3, step to the left to box 2, and step backwards to box 1. These steps can be seen in Figure 2. A timer was started at the beginning of the test, and once the participant completed all steps, the timer was stopped and the time was recorded.

Equine Riding Measures

Core strength measurements were taken during the lesson by asking the participants to do a reach test. This test consists of a series of notches on a pole that were placed arms length from the rider. While on the horse, the rider was asked to take a large ring and reach as far as they could to place the ring on the furthest notch that they could reach. The furthest distance that the rider could reach to place the ring was recorded. The rider then had to be able to re-center themselves on the horse to continue the lesson. Balance measurements were taken through video technology. During the lesson, the participants were videotaped from the side, with parental consent, and the video was used to evaluate posture on the horse using the Gainesville Riding through Equine Assisted Therapy (G.R.E.A.T.) postural scale for reference. The G.R.E.A.T. postural scale is shown in Figure 3. This scale assesses balance and postural control by evaluating five areas of the body: head/cervical spine, shoulders/thoracic spine, pelvis/lumbar spine, hip angle, and knee flexion/heel orientation (Thompson et al., 2014).

Figure 1. Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA) (Gullone & Taffe, 2011).

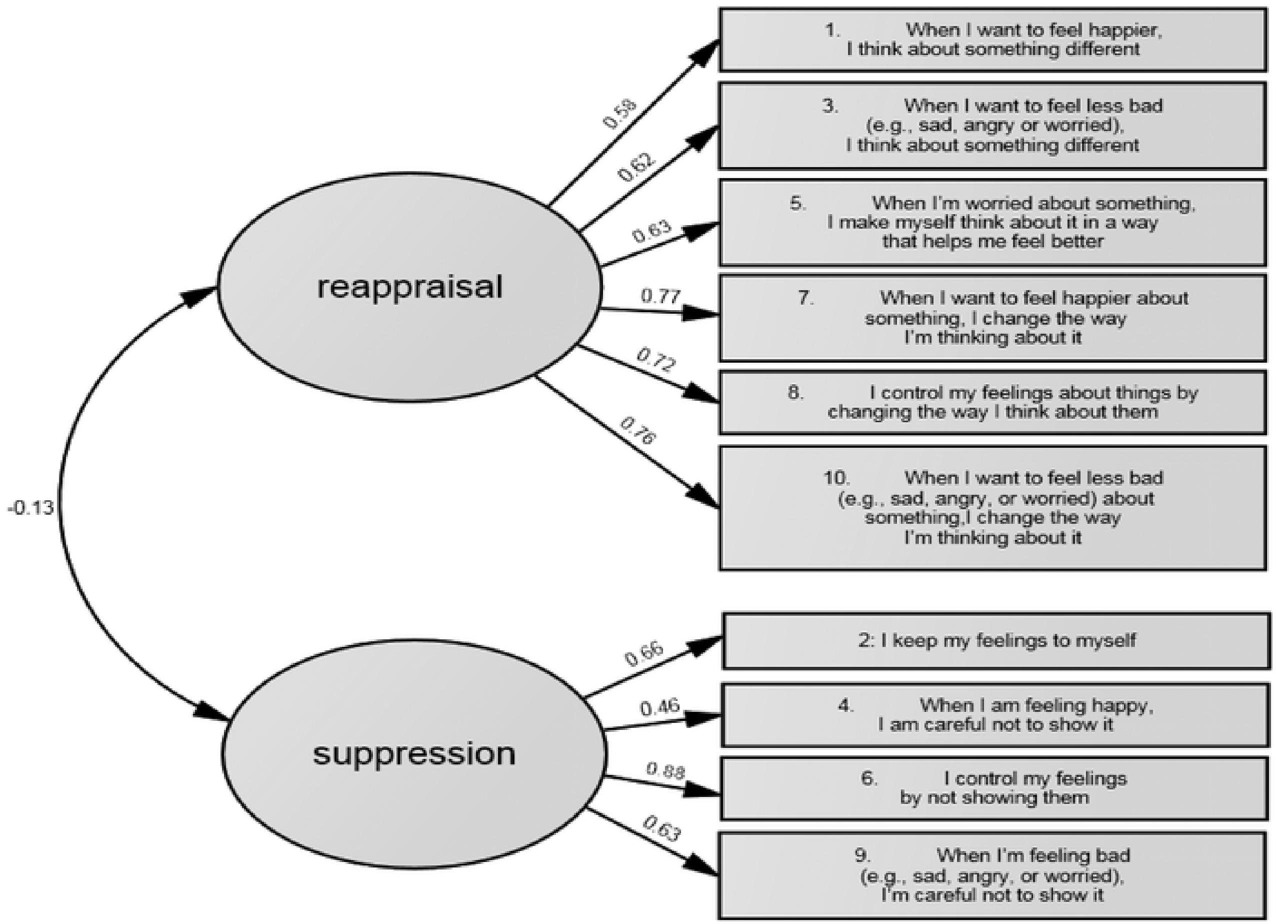


Figure 2. Steps for the Four Square Dynamic Stability Test (*Four Square Step Test*, n.d.).

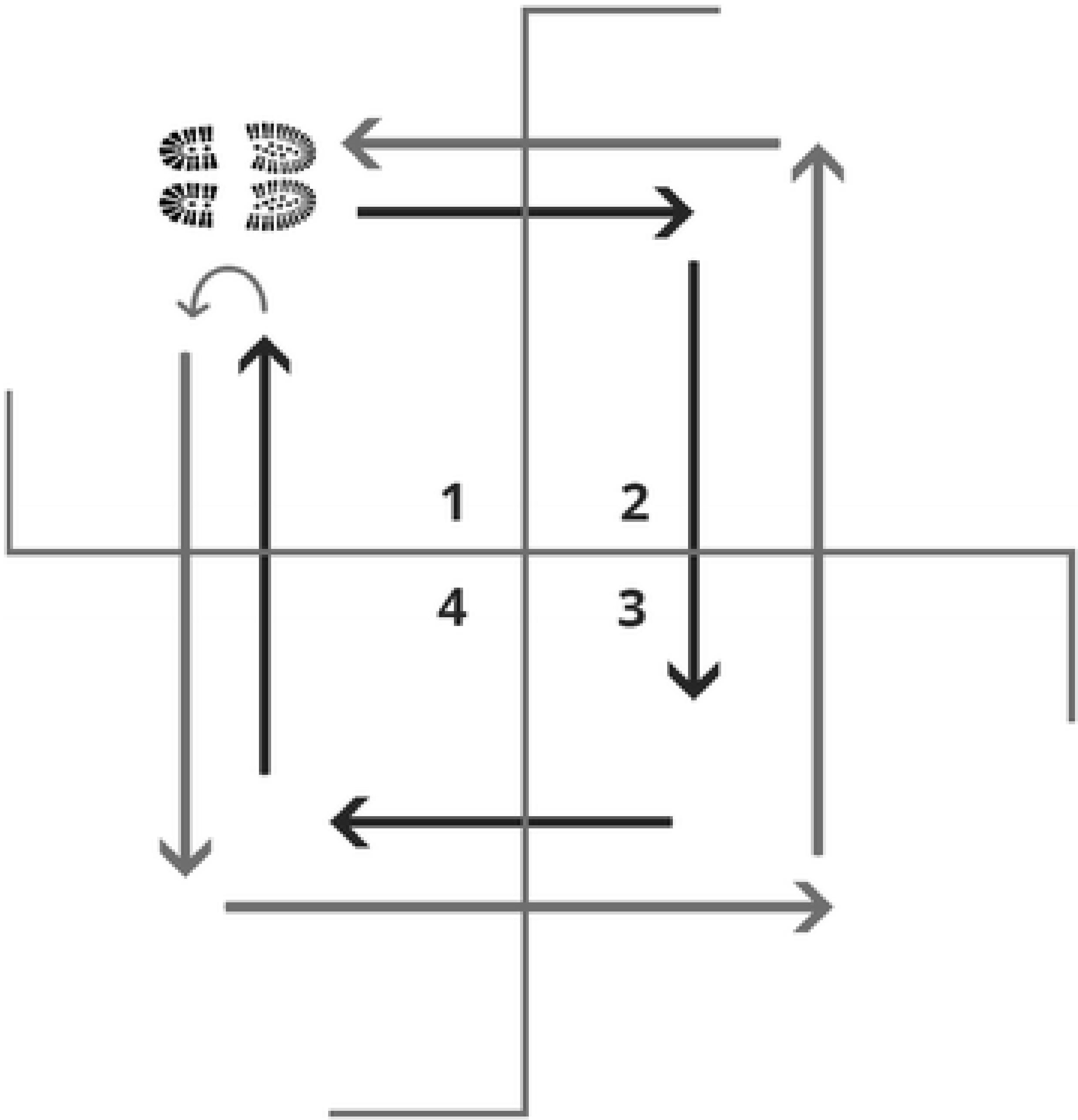
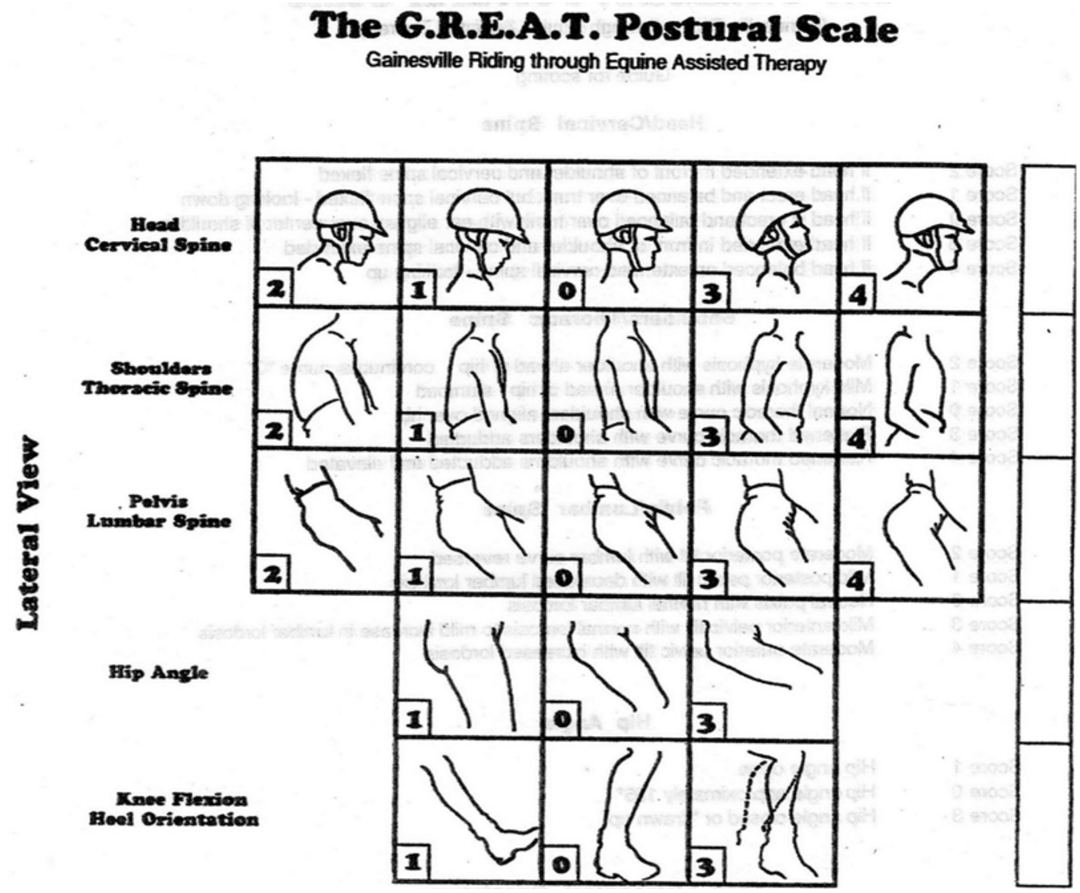


Figure 3. The Gainesville Riding through Equine Assisted Therapy (G.R.E.A.T.) Posture Scale (Thompson et al., 2014)**.**



Statistical Analysis

Data were analyzed first using a one-way analysis of variance (ANOVA) to determine if there were any significant differences between any of the groups and variables. This was done by separating each group into three smaller groups based on the time points. (Group 1: Autistic group at baseline, Group 2: Control group at baseline, Group 3: Autistic group at week 4, Group 4: Control group at week 4, Group 5: Autistic group at week 8, Group 6: Control group at week 8) The ANOVA determined if there was significant differences between any of the 6 groups. After the initial ANOVA was completed, a Tukey HSD Post-hoc analysis was done to determine the specific differences for each group and variable. The level of significance was set at 0.05, *a priori*.

Data were then analyzed using an independent samples T-test to analyze differences between the two groups, as well as a paired samples T-test to analyze change variables within the groups throughout the time intervals. The level of significance was set at 0.05, *a priori*. The independently analyzed dependent variables were emotional regulation scores, 30 second chair stand, the timed up and go, the four square step test, G.R.E.A.T. riding evaluation during straight riding and curved riding, and the riding reach test score. All analysis was completed using SPSS statistical software (IBM, Version 27, Chicago, IL).

Results

Six participants with ASD and six participants without ASD completed the study, though one participant in the control group completed only seven out of the eight weeks, and completed the final testing on week seven. This participant was still included in the analysis. Descriptive data on the participants is shown in Table 1. The variable means and standard deviations for the experimental group and the control group are shown in Table 2 and 3 respectively, as well as Figure 4 and 5.

A one-way ANOVA determined that there was a significant difference between groups for the four square dynamic stability test (p=0.010) and the riding reach test (0.013). However, upon further analysis with the Tukey HSD, we determined that the significant differences were not relevant to our research.

For the four square dynamic stability test, the only significant difference was between group 1 (autistic group at baseline) and group 4 (control group at week 4) with a p=0.034. Group 1 (autistic group at baseline) and group 2 (control group at baseline) were approaching significant differences, with a p=0.063.

For the riding reach test, group 1 (autistic group at baseline) was significantly different from group 4 (control group at week 4) and group 6 (control group at week 8) with p values of 0.021 and 0.049 respectively.

These differences do not represent within-group differences, or between group differences at equal time points, and therefore these differences do not add to our conclusions.

Table 1. Demographics

	N	Age (years)	Height (cm)	Weight (kg)	Time in Program (months)
Experimental Group	6	11.2±2.9	146.8±10.5	46.6±12.6	28.7±21.0
Control Group	6	10.3±3.2	140.7±17.5	37.8±9.0	15.8±6.8

Table 2. Variable Means and Standard Deviations

	Group	**Week 1**	**Week 4**	**Week 8**
EmotionRegulation	Experimental	37.3±13.1	40.8±7.4	40.2±10.3
	Control	37.6±7.6	46.3±6.4	47.3±2.6
30sCS	Experimental	14.5±7.7	16.0±7.0	17.5±7.1
	Control	21.2±5.3	23.5±6.0	26.0±5.8
TUG	Experimental	15.7±10.8	14.9±10.4	10.9±4.7
	Control	6.4±1.2	5.7±1.0	6.0±0.9
Four Square	Experimental	26.6±14.6	22.2±12.0	19.8±10.9
	Control	10.9±1.4	9.4±1.5	9.8±0.7
G.R.E.A.T. S	Experimental	8.0±5.4	4.7±5.0	3.2±2.7
	Control	2.8±3.5	1.8±2.9	1.0±2.0
G.R.E.A.T. C	Experimental	6.8±3.7	4.5±3.0	3.0±2.7
	Control	3.7±4.1	2.7±3.2	0.0±0.0
Reach	Experimental	11.9±10.2	16.1±9.3	24.1±11.0
	Control	22.9±9.1	30.5±6.6	33.0±5.5

Figure 4. Experimental Group Variable Means

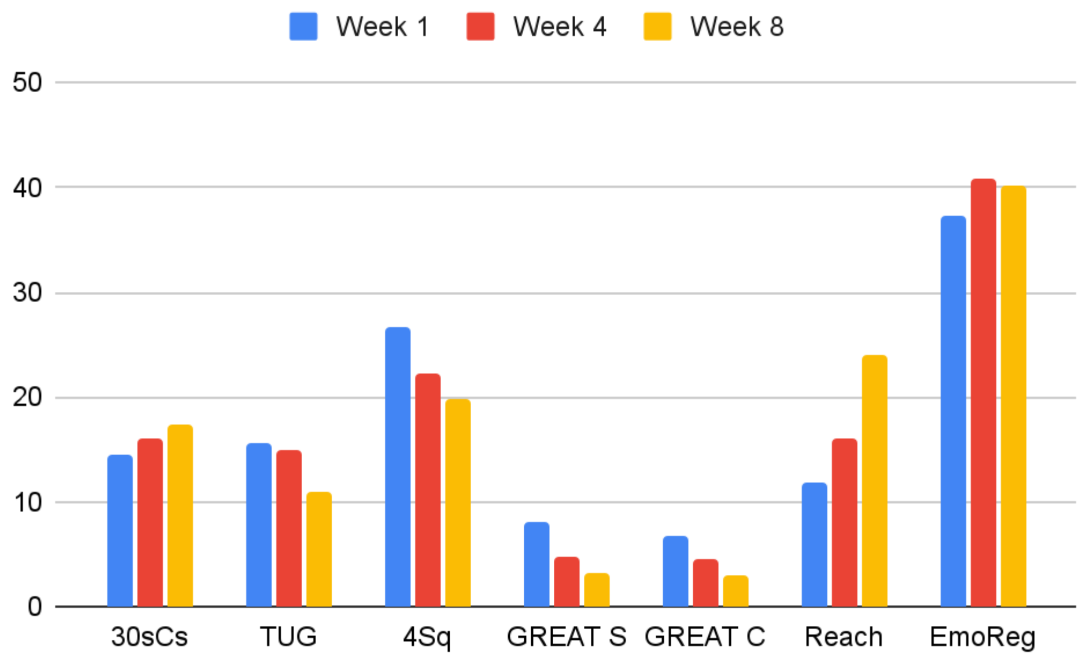


Figure 5. Control Group Variable Means

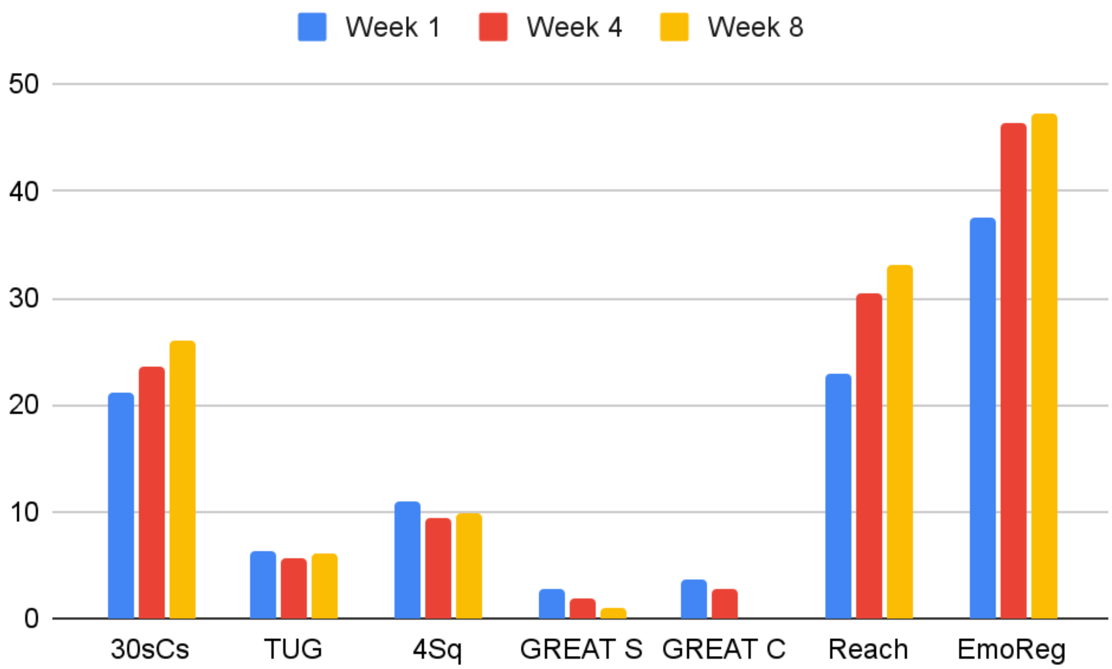
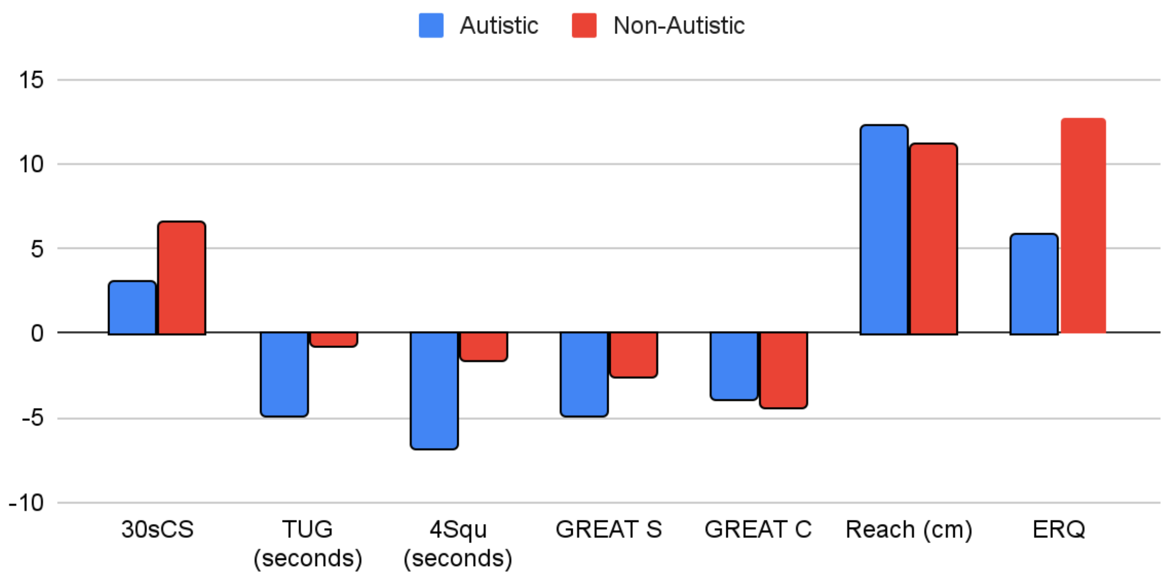


Figure 6. Average Differences in Scores Between Week 1 and Week 8 for the Experimental and Control Groups



Emotion Regulation (ERQ-CA Questionnaire)

The average improvement in ERQ-CA scores overall was 8.75. The average improvement for the autistic group was 5.80 and average improvement for the control group was 12.75 (Figure 6).

There was no significant difference between the experimental group and control group in the ERA-CA scores between baseline and week 4 (t=-1.002, dF=8, p=0.346). However, there was a significant difference between the experimental group and control group in the ERQ-CA scores between baseline and week 8 (t=-2.499, dF=6, p=0.047). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second 4 weeks for the ERQ-CA scores (t=-0.538, dF=4, p=0.619). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the ERQ-CA scores (t=-3.617, dF=2, p=0.069). The means and standard deviations can be found in Table 4.

Mobility and Dynamic Stability Changes Over Time

30 second chair stand (mobility assessment)

The average improvement in 30 second chair stand scores overall was 4.64. The average improvement for the autistic group was 3.00 and average improvement for the control group was 6.60 (Figure 6).

There was no significant difference between the experimental group and control group in the 30 second chair stand scores between baseline and week 4 (t=-0.434, dF=10, p=0.674). There was also no significant difference between the experimental group and control group in the 30 second chair stand scores between baseline and week 8 (t=-1.329, dF=8, p=0.220). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the 30 second chair stand scores (t=-1.695, dF=5, p=0.151). However, there was a significant difference within the control group between the first 4 weeks and the full 8 weeks for the 30 second chair stand scores (t=-3.576, dF=3, p=0.037). The means and standard deviations can be found in Table 4.

Timed up and go (mobility assessment)

The average improvement in timed up and go scores overall was 2.96 seconds. The average improvement for the autistic group was 4.80 seconds and average improvement for the control group was 0.76 seconds (Figure 6).

There was no significant difference between the experimental group and control group in the TUG time between baseline and week 4 (t=-0.122, dF=10, p=0.905). There was also no significant difference between the experimental group and control group in the TUG time between baseline and week 8 (t=-1.331, dF=8, p=0.220). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the TUG time (t=1.587, dF=5, p=0.173). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the TUG time (t=-0.041, dF=3, p=0.970). The means and standard deviations can be found in Table 4.

Four Square Step Test (dynamic stability assessment)

The average improvement in four square step test scores overall was 4.41 seconds. The average improvement for the autistic group was 6.78 seconds and average improvement for the control group was 1.58 seconds (Figure 6).

There was no significant difference between the experimental group and control group in the four square step test time between baseline and week 4 ($t=-0.793$, $dF=10$, $p=0.446$). There was also no significant difference between the experimental group and control group in the four square step test time between baseline and week 8 ($t=-1.871$, $dF=8$, $p=0.098$). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the four square step test time ($t=1.408$, $dF=5$, $p=0.218$). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the four square step test time ($t=-0.187$, $dF=3$, $p=0.864$). The means and standard deviations can be found in Table 4.

G.R.E.A.T. Riding Posture Score During Straight Riding

The average improvement in G.R.E.A.T. riding posture scores during straight riding overall was 3.82. The average improvement for the autistic group was 4.83 and average improvement for the control group was 2.60 (Figure 6).

There was no significant difference between the experimental group and control group in the G.R.E.A.T. straight score between baseline and week 4 ($t=-2.150$, $dF=10$, $p=0.057$). There was also no significant difference between the experimental group and control group in the

G.R.E.A.T. straight score between baseline and week 8 (t=-1.215, dF=8, p=0.259). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the G.R.E.A.T. straight score (t=1.145, dF=5, p=0.304). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the G.R.E.A.T. straight score (t=0.136, dF=3, p=0.901). The means and standard deviations can be found in Table 4.

G.R.E.A.T. Riding Posture Score During Curved Riding

The average improvement in G.R.E.A.T. riding posture scores during curved riding scores overall was 4.09. The average improvement for the autistic group was 3.83 and average improvement for the control group was 4.4 (Figure 6).

There was no significant difference between the experimental group and control group in the G.R.E.A.T. curve score between baseline and week 4 (t=-0.764, dF=10, p=0.462). There was also no significant difference between the experimental group and control group in the G.R.E.A.T. curve score between baseline and week 8 (t=0.178, dF=8, p=0.863). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the G.R.E.A.T. curve score (t=1.567, dF=5, p=0.178). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the G.R.E.A.T. curve score (t=1.722, dF=3, p=0.184). The means and standard deviations can be found in Table 4.

Riding Reach Test (Riding Stability)

The average improvement in reach test scores overall was 11.78 cm. The average improvement for the autistic group was 12.28 cm and average improvement for the control group was 11.18 cm (Figure 6).

There was no significant difference between the experimental group and control group in the reach test scores between baseline and week 4 (t=-1.581, dF=10, p=0.145). There was also no significant difference between the experimental group and control group in the reach test scores between baseline and week 8 (t=0.146, dF=8, p=0.887). The means and standard deviations can be found in Table 3.

There was no significant difference within the experimental group between the first four weeks and the second four weeks for the reach test scores (t=-2.061, dF=5, p=0.094). There was also no significant difference within the control group between the first 4 weeks and the full 8 weeks for the reach test scores (t=-0.351, dF=3, p=0.749). The means and standard deviations can be found in Table 4.

Table 3. Between group differences over time. Independent Samples T-test mean change of dependent variables over time between the autistic group and the non-autistic group, significance set at a p ≤ 0.05.

	Autistic Group Δ Weeks 1-4	Non-autistic Group Δ Weeks 1-4	Autistic Group Δ Weeks 1-8	Non-autistic Group Δ Weeks 1-8
ERQ-CA	4.2±9.7	10.2±9.2	5.8±3.6*	13.7±5.5*
30sCS	1.5±1.9	2.3±4.3	3.0±3.6	6.3±4.0
TUG	-0.8±2.0	-0.7±0.7	-4.8±6.4	-0.4±0.7
4Square	-4.3±8.8	-1.5±0.8	-6.8±5.7	-1.2±1.7
G.R.E.A.T. S	-3.3±2.2	-1.0±1.5	-4.8±3.1	-1.8±5.1
G.R.E.A.T. C	-2.3±3.4	-1.0±2.5	-3.8±2.8	-4.3±4.7
Reach	4.2±2.6	7.6±4.5	12.6±8.6	11.4±9.6
* denotes significance difference with a p-value ≤ 0.05.				

Table 4. Within group differences over time. Paired Samples T-test mean change in dependent variables over time within each group (autism and non-autism groups), with significance set at a $p \leq 0.05$.

	Autistic Group Δ Weeks 1-4	Autistic Group Δ Weeks 1-8	Non-autistic Group Δ Weeks 1-4	Non-autistic Group Δ Weeks 1-8
ERQ-CA	4.2±9.7	5.8±3.6	10.2±9.2	13.7±5.5
30sCS	1.5±1.9	3.0±3.6	2.3±4.3*	6.3±4.0*
TUG	-0.8±2.0	-4.8±6.4	-0.7±0.7	-0.4±0.7
4Square	-4.3±8.8	-6.8±5.7	-1.5±0.8	-1.2±1.7
G.R.E.A.T. S	-3.3±2.2	-4.8±3.1	-1.0±1.5	-1.8±5.1
G.R.E.A.T. C	-2.3±3.4	-3.8±2.8	-1.0±2.5	-4.3±4.7
Reach	4.2±2.6	12.6±8.6	7.6±4.5	11.4±9.6
* denotes significance difference with a p-value ≤ 0.05.				

The mean differences for each group improved over the eight week testing period, though none of the mean differences within the groups were statistically significant. The only significant mean differences were between the autistic group baseline and the control group week 4 for the four square dynamic stability test, as well as the riding reach test, where the autistic group baseline scores were significantly different than the control group week 4 and week 8 scores. These analyses were determined by a one-way ANOVA and a Tukey HSD for Post-hoc analysis, and do not add to our conclusions.

When looking at the average improvement for each dependent variable, the independent samples t-tests showed that the ERQ-CA average improvement scores from baseline to week 8 were significantly different between the experimental and control groups ($t=-2.499$, $dF=6$, $p=0.047$). All other improvements between groups were not statistically significant, although the G.R.E.A.T. straight average improvement scores between the experimental and control groups from baseline to week 4 were approaching significance ($t=-2.150$, $dF=10$, $p=0.057$).

The paired samples t-tests showed that the 30 second chair stand average improvement scores for the control group between the first 4 weeks and the full 8 weeks were significantly different ($t=-3.576$, $dF=3$, $p=0.037$). All other improvements within the groups were not statistically significant, although the ERQ-CA average improvement scores for the control group between the first 4 weeks and the full 8 weeks were approaching significance ($t=-3.617$, $dF=2$, $p=0.069$).

Discussion

The purpose of this study was to determine the effects of 8 weeks of a therapeutic horseback riding program on equine riding performance and emotional regulation, and understand how therapeutic horseback riding affects overground performance: specifically dynamic stability and mobility. We hypothesized that the therapeutic horseback riding program would help the individuals to improve their riding performance, increase emotional regulation, and help to improve skills that will translate into everyday activities of living. While there were improvements, the mean differences were not enough to be significant, and therefore our hypothesis was not supported by the data.

Our results, in which there were no significant mean differences within the groups over the 8 week testing period, are contradicted by earlier research that demonstrated that hippotherapy had an effect on motor control for children with ASD. In the study by Ajzenman et al, motor control and postural stability were significantly improved in six autistic children aged 5-12 who completed 12 weeks of 45 minute sessions of hippotherapy. The data was collected in this study through the use of a video motion capture system and force plates. It is important to note that this study had a longer duration than our study, and that the participants in this study had no prior experience with any equine-assisted therapies (Ajzenman et al., 2013).

Our results showing the non-significant mean differences within groups across variables are also contradicted by a study looking at hippotherapy and gross motor function and functional performance in children with cerebral palsy (CP). This study included 34 children with spastic CP who participated in 8 weeks of 45 minute sessions of hippotherapy, and 21 children with spastic CP who were in a control group. The results showed significant improvements in gross motor function and functional performance measures when compared to the control group (Park et al., 2014). Many aspects of hippotherapy are similar to THR, with the main difference being the credentials of the instructor. However, it is important to recognize that cerebral palsy and autism are very different and the improvements of one disorder following equine interventions may not reflect the other.

In a randomized controlled trial of THR for autistic children and adolescents, researchers found significant improvements in a variety of emotional and cognitive outcomes, such as social cognition, irritability, hyperactivity, and communication. The researchers looked at changes over a 10 week period between a THR intervention group and a barn activity group, which implemented similar practices to the THR group without the involvement of horses. The study used speech therapist and caregiver evaluations to measure the outcome variables, whereas our study used the ERQ-CA, which was adapted from an adult version to be applicable for children and adolescents. In the randomized controlled study, no significant differences were seen between groups for adaptive and motor behaviors, which was assessed via questionnaires and scales completed by occupational therapists. These findings are similar to the non-significant mean differences within groups that we found across all variables throughout our eight week study. The study conducted by Gabriels et al was limited by using broad measures to collect data on motor coordination, and by not having a true control group (Gabriels et al., 2015).

The participants for our study were previously enrolled in their prospective programs at Brook Hill Farm, which provided a significant limitation. The range of time that the participants had already been participating in their program ranged from 5 months to 65 months (5.4 years). There is a possibility that many of the participants have already seen the bulk of their improvements, and are currently in a plateau stage. Sample size was another limitation for this study. The small sample was necessary because participants were recruited from a single barn with limited participants meeting the criteria. The small sample decreases the ability for the results to be applied to a larger population. Another limitation was the duration of the study. Having only eight weeks of therapeutic riding, while also being interspersed by weeks of missed riding lessons because of inclement weather conditions or illnesses provided the possibility of regression of progress that was made. Many of the parents who completed the ERQ-CA on behalf of their child gave feedback stating that the questions were difficult to understand and/or apply to their young child. This could have posed another limitation to the validity of the emotion regulation scores. Two of the participants in the control group attended four weekly riding sessions, while all other participants attended lessons once per week, which could have added another limitation to our ability to our study.

Future research studies could avoid some of these limitations by recruiting a larger sample size, having a longer duration of data collection, using measures for emotional outcomes that are easier to understand, and recruiting participants to begin a THR program instead of studying those who are already enrolled.

Another suggestion for future research would be to look into the effects of THR on adult and/or senior autistic populations, as the findings from this study and similar studies done on children and adolescents may not apply to older age groups.

The results of this study can help to increase the understanding and awareness of THR as a treatment option for children and adolescents with ASD. Furthermore, we hope that our findings will inspire future researchers to explore the complexities of ASD and the many ways in which THR could provide an increase in physical and cognitive abilities as well as overall quality of life for autistic populations.

Works Cited

Ajzenman, H. F., Standeven, J. W., & Shurtleff, T. L. (2013). Effect of Hippotherapy on Motor Control, Adaptive Behaviors, and Participation in Children With Autism Spectrum Disorder: A Pilot Study. *The American Journal of Occupational Therapy*, *67*(6), 653–663. http://dx.doi.org/10.5014/ajot.2013.008383

Elsabbagh, M., Divan, G., Koh, Y.-J., Kim, Y. S., Kauchali, S., Marcín, C., Montiel-Nava, C., Patel, V., Paula, C. S., Wang, C., Yasamy, M. T., & Fombonne, E. (2012). Global Prevalence of Autism and Other Pervasive Developmental Disorders. *Autism Research*, *5*(3), 160–179. https://doi.org/10.1002/aur.239

Four Square Step Test. (n.d.). Physiopedia. Retrieved September 20, 2021, from https://www.physio-pedia.com/Four_Square_Step_Test

Gabriels, R. L., Pan, Z., Dechant, B., Agnew, J. A., Brim, N., & Mesibov, G. (2015). Randomized Controlled Trial of Therapeutic Horseback Riding in Children and Adolescents With Autism Spectrum Disorder. *Journal of the American Academy of Child and Adolescent Psychiatry*, *54*(7), 541–549. https://doi.org/10.1016/j.jaac.2015.04.007

Garner, B. A., & Rigby, B. R. (2015). Human pelvis motions when walking and when riding a therapeutic horse. *Human Movement Science*, *39*, 121–137. https://doi.org/10.1016/j.humov.2014.06.011

Gullone, E., & Taffe, J. (2011). The Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA): A Psychometric Evaluation. *Psychological Assessment*, *24*, 409–417. https://doi.org/10.1037/a0025777

LeClerc, S., & Easley, D. (2015). Pharmacological Therapies for Autism Spectrum Disorder: A Review. *Pharmacy and Therapeutics*, *40*(6), 389–397.

Park, E. S., Rha, D.-W., Shin, J. S., Kim, S., & Jung, S. (2014). Effects of Hippotherapy on Gross Motor Function and Functional Performance of Children with Cerebral Palsy. *Yonsei Medical Journal*, *55*(6), 1736–1742. https://doi.org/10.3349/ymj.2014.55.6.1736

Schug, C. (2018). Use of Hippotherapy in a Pediatric Patient with Right Hemiplegia: A Case Report. *Doctor of Physical Therapy Program Case Reports*. https://ir.uiowa.edu/pt_casereports/69

Srinivasan, S. M., Cavagnino, D. T., & Bhat, A. N. (2018). Effects of Equine Therapy on Individuals with Autism Spectrum Disorder: A Systematic Review. *Review Journal of Autism and Developmental Disorders*, *5*(2), 156–175. https://doi.org/10.1007/s40489-018-0130-z

Thompson, F., Ketcham, C. J., & Hall, E. E. (2014). Hippotherapy in Children with Developmental Delays: Physical Function and Psychological Benefits. *Advances in Physical Education*, *4*(2), 60–69. https://doi.org/10.4236/ape.2014.42009

Wood, W., Alm, K., Benjamin, J., Thomas, L., Anderson, D., Pohl, L., & Kane, M. (2021). Optimal Terminology for Services in the United States That Incorporate Horses to Benefit People: A Consensus Document. *The Journal of Alternative and Complementary Medicine*, *27*(1), 88–95. https://doi.org/10.1089/acm.2020.0415

Zoccante, L., Marconi, M., Ciceri, M. L., Gagliardoni, S., Gozzi, L. A., Sabaini, S., Di Gennaro, G., & Colizzi, M. (2021). Effectiveness of Equine-Assisted Activities and Therapies for Improving Adaptive Behavior and Motor Function in Autism Spectrum Disorder. *Journal of Clinical Medicine*, *10*(8), 1726. https://doi.org/10.3390/jcm10081726