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The Physical Therapeutic Benefits of Hippotherapy on Children with Physical Disabilities

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Table of Contents

Chapter Page

List of Tables

Table Page

Chapter 1: Introduction

Hippotherapy is a type of therapy that involves the use of a horse. These therapies include physical therapy, occupational therapy, or speech therapy and are done under the guidance of licensed professionals (Rigby & Grandjean, 2016). The different forms of therapy can take place through riding, driving, grooming, and caring for horses. Hippotherapy is not as common as the usual forms of therapies and may be viewed as an alternative therapy approach.

Hippotherapy has been around for thousands of years, dating back to Hippocrates. He was the first physician on record to report that horses can be used to rehabilitate people with disabilities (Granados & Agis, 2011). Greek and Roman soldiers used horses in the fifth century B.C.E. to help rehabilitation after being wounded in battle (Rigby & Grandjean, 2016).

The purpose of this paper was to inform people of the benefits of hippotherapy, particularly in children with disabilities. While hippotherapy can have positive results on many different components of a person's being, I will look specifically at the physical benefits that children experience from it.

Research Question

There is one research question guiding this review of literature: What are the physical benefits of hippotherapy on children with disabilities?

Focus of Paper

There are 11 studies included in this review of literature, dating from 2011-2017. The articles include participants who were considered children, under the age of 18. I gathered this information through Academic Search Premier and PsycInfo databases. Keywords used for searches include combinations of the words: hippotherapy, horse therapy, equine therapy, children, and physical disabilities.

While there are many reported benefits to hippotherapy, this literature review looks at the physical benefits experienced by children with movement disorders, including the following disabilities: cerebral palsy, pervasive developmental delay, autism, down syndrome, visual impairment, cerebellar hypoplasia, developmental coordination disorder, dyspraxia, and spastic diplegia. The physical benefits include improvement in gross motor, balance, posture, spasticity, and gait.

Importance of the Topic

Horses are amazing animals. People experience many benefits from being around horses that go beyond the physical improvements seen through therapy (Granados & Agis, 2011). Riding, touching, and simply being around horses can release endorphins, which produce happy feelings in a person. It can also help children develop positive traits such as self-esteem, empathy, self-concept, and self-control (Dingman, 2008; Granados & Agis, 2011; Hsieh et al., 2017; Jang et al., 2015). Children also benefit from the social interaction involved in the therapy. Many children with disabilities experience a lack of social skills and may not know acceptable ways of communication; they may also lack the language to communicate. Working with a horse involves some verbal communication, but mostly non-verbal communication. Children learn how their actions and body can send a message to another person or animal, without using words. Through this, children can learn what a horse likes, does not like, or what might scare a horse (Granados & Agis, 2011). Children that have never been able to relate to people, can often times relate to animals.

While the previously listed advantages are valuable, the benefits of hippotherapy I will be reviewing are the physical improvements. Hippotherapy is a great choice for children; there are advantages to a child improving multiple aspects of their life through one activity. It also is an

enjoyable activity that seems more fun than work. Kwon et al., (2015), postulated "another potential reason for the beneficial effect of hippotherapy could be the human-horse interaction acting as a powerful motivator for engaging children's participation" (p. 19). Not all children like animals, but those who do may experience greater results from hippotherapy than a traditional approach.

What is Involved in a Hippotherapy Session

Hippotherapy sessions typically occur one to two times per week and may last from 20 to 40 minutes. Therapy sessions are run by a therapist licensed in speech/language therapy, occupational therapy, or physical therapy. There is also usually someone leading the horse and one or two people walking alongside the horse and rider for safety. During the sessions, participants engage in various activities and exercises activating muscles throughout the body (Kwon et al., 2015). Some activities include stretching, throwing, catching, lying, or standing in the stirrups (Champagne, Corriveau, & Dugas, 2017). These activities are often times carried out through games and are fun and engaging for the child. These movements while on a horse are especially beneficial for children who have limited mobility because the movement of riding a horse mimics that of a person walking; therefore allowing the rider to experience the motions without needing to actually walk themselves (Rigby & Grandjean, 2016; Silkwood-Sherer, Killian, Long, Martin, 2012). Children where a helmet while riding the horse and usually sit on a pad on the horses back rather than in a saddle to get as much natural movement from the horse as possible. Champagne et al. (2017) reported, "a full-sized horse transfers about 110 multidimensional swinging motions to the rider each minute while walking… in a 30-minute therapy session, a horse walking at 100 steps/minute will induce over 3,000 steps" (p. 52).

Therapy sessions end in a 'cool down' and some may end with the children taking care of the horse afterwards by brushing or feeding it.

List of Terms

Cerebellar Hypoplasia: "A neurological condition in which the cerebellum is not completely developed or is smaller than it should be...The most common findings are developmental and speech delay, poor muscle tone, ataxia and abnormal ocular (eye) movements." (https://rarediseases.info.nih.gov/diseases/1194/cerebellar-hypoplasia.)

Cerebral Palsy: "A neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development. Cerebral Palsy primarily affects body movement and muscle coordination. (www.cerebralpalsy.org/about-cerebral-palsy/definition.)

Developmental Coordination Disorder: "A motor skills disorder that affects 5-6% percent of all school-aged children… a delay in the development of motor skills, or difficulty coordinating movements, results in a child being unable to perform common, everyday tasks." (https://canchild.ca/en/diagnoses/developmental-coordination-disorder.)

Dyspraxia: "A brain-based condition that makes it hard to plan and coordinate physical movement. Children with dyspraxia tend to struggle with balance and posture." (https://www.understood.org/en/learning.../child.../dyspraxia/understanding-dyspraxia.)

Equine Therapy: "Equestrian therapy (also known as equine therapy or Equine-Assisted Therapy [EAT]) is a form of therapy that makes use of horses to help promote emotional growth." (www.equestriantherapy.com/.)

Hippotherapy: "The use of the movement of the horse as a strategy by Physical Therapists, Occupational Therapists, and Speech-Language Pathologists to address impairments, functional limitations, and disabilities in patients with neuro-musculoskeletal dysfunction." (www.americanhippotherapyassociation.org/hippotherapy/introduction-to-hippotherapy/.)

Pervasive Developmental Delay: "A category of developmental delays that included Autism, Asperger syndrome, Rett syndrome, Childhood disintegrative disorder, and Pervasive developmental disorder not otherwise specified...in 2013 [with the new] DSM-5, all five of the separate categories were grouped into the new definition for autism spectrum disorder." (https://www.appliedbehavioranalysisedu.org/what-is-pervasive-developmental-disorder/.)

Spastic Diplegia: "A form of cerebral palsy, a neurological condition that usually appears in infancy or early childhood, and permanently affects muscle tone which leads to spasticity (stiff or tight muscles and exaggerated reflexes) in the legs." (https://rarediseases.info.nih.gov/diseases/9637/spastic-diplegia-cerebral-palsy.)

Spasticity: "A condition in which certain muscles are continuously contracted. This contraction causes stiffness or tightness of the muscles and can interfere with normal movement, speech, and gait." (www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/Spasticity.)

Chapter 2: Review of Literature

I have found 11 studies reviewing the physical benefits children experience through hippotherapy. The studies range from 2011-2017 and include research results indicating improvements in gross motor function, balance, posture, spasticity, and gait. The children throughout the studies range in age from 1 to 18 years of age. This chapter will be broken into five sections: gross motor, balance, posture, spasticity, and gait.

Table 1

Tests Used Throughout Research Findings

NAME OF TEST	ABBREVIATION	WHAT/HOW IT MEASURES
Pediatric Balance Scale	PBS	The PBS is a standardized 14-item scale measuring timed single-leg stance, tandem stance, alternating stool touch, and forward reach.
Gross Motor Function Measure (66, 88)	GMFM- 66 GMFM- 88	The GMFM measures five dimensions of gross motor usage: (A) lying and rolling; (B) sitting; (C) crawling and kneeling; (D) standing; (E) walking, running, jumping.
Internal Classification of Functioning, Disability and Health-Children and Youth	ICF-CY	The ICF-CY measures various aspects of children's functioning from cognitive, to physical. There are 55 categories measured by the ICF-CY.
EMG biofeedback device—Neuro Trac		The EMG biofeedback device uses electrodes placed on the body that measure increases and decreases in muscle tension.

GAITRite Pressure Mapping System	GAITRite	The GAITRite is an 18-foot-long floor mat system that measures foot function, gait, stride length, cycle time, and other walking/foot functions.
Modified Ashworth Scale	MAS	The MAS is a rating scale that measures muscle resistance.
Formetric Instrument System		This system conducts a three-dimensional scan of a person's back and uses computer analysis to determine the geometry of that person's spine.

Table 1 (continued)

NAME OF TEST	ABBREVIATION	WHAT/HOW IT MEASURES
Bruininks- Oserestsky Test of Motor Proficiency- Short Form	BOT2-SF	This assessment measures fine motor control, manual dexterity, body coordination, strength, and agility.
Wireless Inertial Measurement Unit Device	IMU	This device measures spatial-temporal gait parameters wirelessly. It is worn on the person's waist and sends signals of the person's motion analysis via Bluetooth to a computer program.

Gross Motor Function

Kwon et al. (2015) conducted a trial in Korea to find the gross motor improvements in children who participated in hippotherapy. Their hypothesis was that children receiving hippotherapy would have improvements in their gross motor functioning and that the amount of improvement may differ depending on the severity of the disability. The study used 92 children diagnosed with cerebral palsy, ages 4 to 10. Of the 96 children in this study, they were split in half for a hippotherapy group and a control group (each having 46 children). Therapy sessions were 30 minutes each, twice per week, administered by a physical therapist trained in techniques through the American Hippotherapy Association. Children assigned to the control group practiced 30 minutes of aerobic exercise, including walking or cycling, in their homes twice per week for 8 weeks as well. Children in both groups (hippotherapy and control) were also participating in physiotherapy simultaneously.

The study measured the children's functioning levels with the Gross Motor Function Measure. This assessment has 88 items in five dimensions: (a) lying and rolling; (b) sitting; (c) crawling and kneeling; (d) standing; and (e) walking, running, and jumping (Kwon et al., 2015). Children were administered the Gross Motor Function Measure before therapy sessions

started, as a baseline, as well as after the 16-week program to obtain the results. Independent *t*-tests, Wilcoxon signed-rank tests, and Mann-Whitney tests were used to analyze data.

The researchers found a significant increase in scores of the children assigned to the hippotherapy group, from baseline to post-intervention, while there was not a statistically significant difference between scores of the children in the control group. The areas where children improved are: sitting, crawling, kneeling, standing, walking, running, and jumping. There was no significant improvement in the lying and rolling area of functioning. This study supports hippotherapy as a beneficial way to improve gross motor function. The large sample size, the diverse range of functioning levels, and the criteria on which participants were chosen, are all strengths of this study.

This study does have some limitations to note. It did not ensure participants were solely using hippotherapy or aerobics as their only therapy. Participants were concurrently using physiotherapy as well as any other individual therapies they may have been participating in. Researchers also assigned the control group to home based activities not overseen by therapists.

Purohit, Vyas, and Sheth (2015) conducted another study in India finding beneficial effects of hippotherapy on children with spastic diplegia (a form of cerebral palsy). Researchers hypothesized that hippotherapy sessions would improve gross motor function, balance, and spasticity in children with spastic diplegia. This study took place in India and included 16 children ages 3 to 10 who had spastic diplegia (a form of cerebral palsy). Two groups were made with 16 children each, for a control group and an experimental group. Children in each group received neurodevelopmental therapy, while the experimental group received hippotherapy in addition to neurodevelopmental therapy. Therapists use neurodevelopmental therapy as a sensorimotor approach to improve physical abnormalities through physical

stimulation, task performance, and certain physical activities aimed toward the use of certain muscles. Children in the experimental group received an additional 15 minutes of hippotherapy twice weekly for 4 weeks. This study measured balance, gross motor function, and spasticity with the Pediatric Balance Scale, Gross Motor Function Measure, and the Modified Ashworth Scale. Children were assessed before therapy as a baseline and again after the 1 month trial period for post intervention scores.

Purohit et al. (2015) stated that "the walking horse transmits some 110 three-dimensional movement impulses per minute onto the person on its back: forward-backward, side to side, up and down, and rotational movements" (p. 4). This is why hippotherapy is so effective because it can provide all that movement and stimulation without the person needing to be able to bear their own weight. This gives the rider many benefits from gross motor function and balance to decrease in spasticity, as well as others.

Statistical analysis was done using the Wilcoxon test and Mann Whitney U test, with a significance level of $p < 0.05$. What researchers found was both groups improved their posture and balance through the neurodevelopmental therapy alone; however, there was no significant difference between the control and experimental group. The group receiving hippotherapy, however, had significant improvement in gross motor function, as measured by the Gross Motor Function Measure over the control group. The areas with significant improvement are walking, running, and jumping. This study indicates hippotherapy is an effective treatment in improving gross motor function in children with cerebral palsy, but it may not be more effective than neurodevelopmental therapy for improvement of posture and balance.

A limitation of this study is the small sample size, with only eight children in the experimental group. Another limitation is the length of both the therapy sessions and how many

weeks they lasted. Many sessions usually run longer than 15 minutes and go for more than 4 weeks. Researchers did not find significant improvement in posture and balance after the study was completed, but maybe they would have if the sessions were longer or went for more than a month.

A study conducted in Canada by Champagne, Corriveau, and Dugas (2017) also revealed the benefits of hippotherapy on gross motor skills in children with cerebral palsy. Their hypothesis was that 10 weeks of hippotherapy sessions would improve children's motor function. There were 13 children in this study, ages 4 to 16 years old. All children had a diagnosis of cerebral palsy, but are able to walk independently. This study took place over a period of 23 weeks broken into phases as follows: a) baseline phase: two baseline scores were obtained three weeks apart from each other; b) intervention phase: 10 weeks of hippotherapy with an assessment after the last session; and c) follow-up: another assessment was given 10 weeks after therapy sessions ended. Researchers were looking to find immediate as well as lasting improvement from hippotherapy.

Hippotherapy sessions in this study include 30 minutes of riding therapy as well as 30 minutes of other horse care activities including feeding, riding preparation, and practice getting on and off the horse. Sessions were led by an occupational therapist who is trained and experienced in hippotherapy. During the riding part of the session children engaged in the following positions on the horse: (1) forward sitting, (2) backward sitting, (3) side sitting, (4) prone over the barrel (lying down on the stomach perpendicularly to the horse's back), (5) prone on forearms, (6) quadruped facing backward, (7) kneeling facing forward, and (8) standing in the stirrups. These exercises were carried out in the order listed, which go from least to most difficult, giving the rider a wide range of muscle stimulation, strengthening, and

stretching. The therapist also had riders catch and throw as well as do stretches on the horse, while it was walking.

Children's motor abilities were measured through the Bruininks-Oseretsky Test of Motor Proficiency-Short Form and the Gross Motor Function Measure-88. Statistical analysis was done with Shapiro-Wilk test and Wilcoxon matched pair signed rank test with both significance levels at $p < .05$. Baseline scores between the control and experimental groups did not differ for the following subtests of the Bruininks-Oseretsky Test of Motor Proficiency: strength, fine motor integration, balance, speed, and agility. Subtests including manual dexterity, bilateral coordination, and upper limb coordination, however, did have significantly different scores at baseline; these areas are considered unstable. On the Gross Motor Function Measure, scores on subtests of standing, walking, running, and jumping did not differ between the two groups, indicating stability.

Researchers found hippotherapy to have significant improvements in total scores for both assessments. Subtests that had statistically significant scores include fine motor precision, balance, and strength (from the Bruininks-Oseretsky Test of Motor Proficiency) and standing, walking, running, and jumping (from the Gross Motor Function Measure). Researchers note that it is interesting that riding a horse can cause improvement in fine motor activities. They speculate that it is probably related to increased trunk control, as this can have a positive impact on upper limb control. Children were found to have an increase in their abdominal and proximal arm strength, as measured by the Bruininks-Oseretsky Test of Motor Proficiency. These improvements are shown through the increased scores on the Gross Motor Function Measure subtests of standing, walking, running, and jumping. All these areas will improve with an increased strength of abdominal muscles. Researchers note that if people want more long term

benefits from hippotherapy, there needs to be increased muscle strength included in the stretching, flexibility, coordination, etc. This study conducted a follow up assessment 10 weeks after hippotherapy sessions had ended and found that these scores in strength did not significantly change in that amount of time. Balance was another area of significant improvement. This was shown through better coordination while walking on a straight line, balance beam (measured on the Bruininks-Oseretsky Test of Motor Proficiency), and standing, walking, running, and jumping (measured on the Gross Motor Function Measure). These improvements can also be related to the improvement in abdominal muscle strength and trunk stability.

This study demonstrates that hippotherapy is a beneficial form of treatment for improving gross motor functions for children with cerebral palsy. A strength of this study is it uses two different assessments to measure gross motor function, the Bruininks-Oseretsky Test of Motor Proficiency and the Gross Motor Function Measure. The researchers use those two assessments in conjunction with each other to show how improvements in certain domains cause improvements in other areas; for instance, the increase in abdominal strength improved children's standing, walking, running, and jumping, as measured through both assessments.

There are a couple limitations to this study, one being the low number of children in the study. This could cause errors, prevent generalizability, and not accurately represent the population. Champagne et al. (2017) noted another limitation could be bias through the Hawthorne effect, where the children may have performed better just from knowing they were being studied and assessed.

Table 2

Studies of Gross Motor Function

AUTHORS	PARTICIPANTS	MEASUREMENT TOOLS	FINDINGS
Kwon, Chang, Yi, Lee, Shin, & Kim (2015)	- 92 children - Disability: Cerebral Palsy - 4-10 years old	- Gross Motor Function Measure- 88	- Significant improvement in gross motor function and balance: sitting, crawling, kneeling, standing, walking, running, and jumping.
Purohit, Vyas, & Sheth (2015)	- 16 children - Disability: Spastic Diplegia - 3-10 years old	- Gross Motor Function Measure- 66, 88	- Significant improvement in gross motor function scores: walking, running, and jumping.
Champagne, Corriveau, & Dugas (2017)	- 13 children - Disability: Cerebral Palsy - 4-12 years old	- Gross Motor Function Measure-88 - Bruininks-Oserestsky Test of Motor Proficiency-Short Form	- Gross and fine motor functions and performance were improved: standing, walking, running, and jumping.

Balance

In a study from 2012, Silkwood-Sherer et al. researched if hippotherapy is a beneficial intervention for increasing balance in children with movement disorders. The study was conducted in the United States and included 16 children ranging from 5 to 16 years old. The study participants had the following diagnosis: pervasive developmental delay, autism, cerebral palsy, down syndrome, visual impairment, cerebellar hypoplasia, and developmental coordination disorder. The children participated in two hippotherapy sessions per week, 45 minutes in length, for 6 weeks. During therapy sessions, the horse was led by an experienced horse handler and a second person walked alongside the horse in addition to the main person

providing the hippotherapy treatment. The horses are trained for hippotherapy treatments along with the therapist. Therapy sessions were tailored individually for each participant based on their responses to the activities and fatigue level, however, all participants experienced similar activities and had comparable sessions overall.

Silkwood-Sherer et al. (2012) used the Pediatric Balance Scale to score participants on their balance, both before (as a baseline) and after the 6 weeks of hippotherapy sessions. Before therapy sessions began, participants were tested twice to obtain two baseline measurements, thus ensuring the reliability of the measurements. To further give reliability to this study, participants were videotaped while being administered the Pediatric Balance Scale examination for baselines and results. Those videos were then sent to three pediatric physical therapists in random order and scored by them, not knowing which were baseline videos versus results videos to increase the interrater reliability of the study.

Data from this study were analyzed through Wilcoxon signed rank tests and Spearman rho analysis. The results of this study show statistically significant scores on the Pediatric Balance Scales from the baseline to the results. There was not a significant difference between the two baseline scores according to *post hoc* analysis. Researchers did an analysis to find the correlation of each subtest with the overall score in order to see which subtests had the biggest increases. The following are the test items with the highest correlation in order from highest first: single-leg stance, tandem stance, alternating stool touch, and forward reach. Overall, results find hippotherapy sessions to be beneficial for improvements in balance as found through the Pediatric Balance Scale.

A limitation of this study is it did not use a control group of children not using hippotherapy. Another limitation is it took the two baseline measurements only a week apart,

rather than matching it to the length of the intervention. This would have shown if there is an increase in scores due to maturation of the participant.

Another study by Kwon et al. (2015), as referenced previously, reported the improvement of balance for children receiving hippotherapy. This study, conducted in Korea, was looking for the benefits of hippotherapy on gross motor function and balance for children with cerebral palsy. Therapy sessions were 30 minutes long and were held twice weekly for 8 weeks. The researchers used the Pediatric Balance scale to measure balance in children before therapy and then again after therapy sessions ended. What they found was the baseline scores between the control and experimental groups did not have a significant difference; however, after the 8 weeks of therapy sessions, the group receiving hippotherapy had significant improvement in scores compared to the control group. According to results from this study, hippotherapy does appear to be effective in improving balance in children with cerebral palsy.

Table 3

Studies of Balance

AUTHORS	PARTICIPANTS	MEASUREMENT TOOLS	FINDINGS
Silkwood-Sherer, Killian, Long, & Martin (2012)	- 16 children - Disabilities: pervasive developmental delay, autism, cerebral palsy, down syndrome, visual impairment, cerebellar hypoplasia, and developmental coordination disorder. - 5-17 years old	- Pediatric Balance Scale	- Significant improvement on single-leg stance, tandem stance, alternating stool touch, and forward reach.
Kwon, Chang, Yi, Lee, Shin, & Kim (2015)	- 92 children - Disability: Cerebral Palsy - 4-10 years old	- Pediatric Balance Scale	- Significant improvement in balance scores

Posture

A study was done in Poland by Lakomy-Gawryszewska et al. (2017) to find the benefits of hippotherapy on trunk stabilization for children with cerebral palsy. Their hypothesis was that hippotherapy will improve trunk control and muscle coordination in children with physical disabilities. The study included 24 children in the age range of 2 to 18 years old. Participants engaged in therapy sessions twice per week throughout the study. Children were given a physiotherapeutic assessment twice before hippotherapy sessions to establish a baseline and again after the 3 months of therapy for post-intervention results.

Researchers used an EMG biofeedback device along with a general medical interview for the physiotherapeutic assessment. The EMG device measures the muscle tension of the rectus

abdominis muscles, which are used for trunk stability and posture. Researchers were looking for an increase in the tension of those muscles, meaning they were getting stronger and posture was improving. When sitting on a walking horse "the motor impulses transmitted from the horse's limbs to its back are then transferred to the patient riding on the horse's back" (p. 10). This gives the rider specific movements which strengthen muscles and improves coordination, resulting in an improvement in overall posture.

After the 3 months of hippotherapy sessions, Lakomy-Gawryszewska et al. (2017) found the majority of children in this study to have a significant increase in muscle tension of the rectus abdominis indicating increased muscle strength, and improvement in trunk stability and posture. Results were greater for children who could walk on their own versus children who used a wheelchair. The 54% of children using wheelchairs showed improvement in trunk stability, while 92% of children who could walk on their own improved their stability. Results from this study suggest hippotherapy is a valid way to improve posture in children with physical limitations. A strength of this study is that it uses an EMG biofeedback device, giving objective test results. Information is not biased by opinion or subjective assessments.

A limitation of this study was that it does not use statistical analysis to prove the significant differences found in pre and post treatment results. Another limitation of this study was that it does not have a control group, it only uses post-intervention scores against baseline scores to show improvement in trunk stability.

Another study was done in Egypt by El-Meniaway and Gehan (2012) looking at the improvement of posture and back geometry after hippotherapy sessions. This study used 30 children with spastic diplegia, ages 6 to 8. All the children in the study were able to stand and walk independently, however, abnormally due to their muscle spasticity.

Two groups were created, a control group and an experimental group, with 15 children per group. The study consisted of both groups receiving a traditional exercise program involving stretches, muscle strengthening, balance activities, and gait training. Children participated in these exercises three times per week for an hour each session. The experimental group also received hippotherapy in addition to the traditional exercises. During the hippotherapy sessions, children rode in two 15-minute sessions, with a 10-minute break in between. During the first half of the session, the therapist helped the child sit properly to support correct posture and alignment. After the 10-minute break, the second half of the therapy session was aimed at getting the child to sit and balance on the horse on his/her own while doing different exercises and stretches. This further strengthens the muscles because the child is relying on their own body to support themselves, while the therapist stayed by the child's side to ensure safety. Therapy sessions were held once per week, for 12 weeks.

Researchers used the Formetric Instrument System to measure the geometry of the spine of participants. This tool does a three-dimensional scan of a person's back and a computer system analyzes it to determine the degree of impairment in the child's back geometry. Data analysis was done using Levene's test, independent *t*-test, and paired *t*-test. Baseline data showed no significant difference between the two groups. Post-treatment data showed a significant difference from baseline data in both groups, as well as significant improvement of the hippotherapy group over the control group. This study found traditional exercise to be a beneficial form of therapy, but hippotherapy has even greater improvement in children's posture. A strength of this study is it had both groups participating in common exercises used to improve posture for children with spastic diplegia. This shows that hippotherapy is even more effective than just exercises alone. Another strength is results are measured by an objective computer

system, reducing bias which can be found through scales or other subjective forms of measurement.

A limitation of this study was that it only it only had one baseline data collection. Having two baseline data points spaced out as long as therapy treatment lasts, in this case, 12 weeks, gives a more accurate estimation of participant's scores, based on changes that could occur in that length of time.

Table 4

Studies of Posture

AUTHORS	PARTICIPANTS	MEASUREMENT TOOLS	FINDINGS
Lakomy-Gawryszewska, Jozefowicz, Raniszewska, Langer, Hansdorfer-Korzon, Bieszczad, Gorska, Cichon-Kotek, & Pilarska (2017)	- 24 children - Disability: spastic infantile cerebral palsy - 2-18 years old	- Physiotherapeutic assessment with EMG biofeedback device	- Majority of participants had an increase abdominal strength
El-Meniawy & Thabet (2011)	- 30 children - Disability: spastic diplegia - 6-8 years old	- Formetric Instrument System	- Improved sensory feedback and back geometry

Spasticity

A study was conducted in Turkey by Almendaroglu et al. (2016) looking at the benefits of horseback riding therapy in addition to traditional rehabilitation for children with cerebral palsy. Researchers were looking to find improvement in spasticity after hippotherapy sessions. Spasticity refers to muscles that are continuously tightened or contracted which can impede natural movement of the body. Cerebral palsy is known for causing spasticity in the muscles,

resulting in many forms of physical impediments of the people who have it. This study included 16 children who were 4 or more years old.

Children were split into two groups; a control and an experimental group. Children in both groups received a traditional therapy program 5 days per week throughout the 5-week trial; children in the experimental group participated in hippotherapy sessions twice per week for 30 minutes each time in addition to the other exercises. The traditional exercise program "comprised of range of motion exercises, progressive resistive strengthening, posture exercises, neurophysiological exercises, balance and coordination training, ambulation training, orthotic and ambulation aid training, stretching, and heat and electrical stimulation" (Almendaroglu et al., p. 27). During the hippotherapy sessions, children were doing additional exercises on horseback, directed by the therapist.

Spasticity of each child was measured through the Ashworth Scale at the beginning of the trial and again after the 5 weeks of therapy sessions. Data analysis was done using the Wilcoxon signed-rank test and Mann-Whitney U test with statistical significance set at $p < 0.05$. Researchers found children in the experimental group had significant improvement in scores on the Ashworth Scale compared with children receiving only conventional treatment, who did not have significant improvement in spasticity. Children in the hippotherapy group had an average of 22% change in hip adductor spasticity, while children in the control group had 0% change. This study shows evidence for the benefit of hippotherapy for children with spasticity problems, such as those with cerebral palsy.

A limitation of this study was that the small sample size was only 16 children total. Another limitation was that all children were participating in another rehabilitation program besides the hippotherapy, which could have been part of the improvement found in the scores.

Alemdaroglu et al. (2016) do, however, argue that there are still more improvements found in the hippotherapy group versus the control group.

Antunes et al. (2016) carried out a study in Brazil looking at immediate effects of hippotherapy on children with cerebral palsy. Their hypothesis was "that the walk-trot protocol would be able to reduce the spasticity of the hip adductors and improve spatio-temporal gait parameters" (p. 66). The children used in this study were 5-15 years old and all had cerebral palsy but were able to walk (with supports as needed). Researchers used 10 children in the study group and had 10 healthy children, matching in ages, as the control group. Children were not receiving any other type of therapy treatment while in this study. The Modified Ashworth Scale was used to measure each child's spasticity levels, before and after each session.

This study is unique in that it is not looking at a typical 8 or 12 week therapy period, but rather the immediate effects after just one 30-minute hippotherapy session. Two sessions were held, one with the horse only walking the entire time, and another where the horse went in intervals between walking, walking fast, and trotting. The study group was split in half and one group did the walk protocol the first week, then the walk-trot protocol a week later. The other group did the walk-trot protocol the first week and the walk protocol the next week. The two different sessions were done a week apart from each other to reduce carryover effect. A physiotherapist trained in the guidelines from the American Hippotherapy Association conducted the sessions; however, they did not have the children do additional motor tasks on the horse as hippotherapy sessions usually do. The researchers wanted to see what the horseback riding alone will do to improve functioning levels, therefore didn't want extra exercises and movements included.

Statistical analysis for this study was done through the Mann-Whitney *U* test, paired

t-test, and the Wilcoxon rank test, with the significance level at $a < 0.05$. Results showed no difference in baselines given on the two different days (1 week apart from each other). Researchers found a significant improvement in spasticity of the children after both the walk protocol and the walk-trot protocol. Both forms of hippotherapy appear to be effective in reducing spasticity in children with cerebral palsy. Additionally, during the walk-trot protocol, children had a significant decrease in muscle tone, an improvement related to decreased spasticity. The researchers' hypothesis was correct in predicting that hippotherapy sessions would improve spasticity immediately even after just one session.

This study by Antunes et al. (2016) does have some limitations including the small sample size and the fact that the children in this study had heterogeneous characteristics, which may not accurately portray the population of children with cerebral palsy. Another limitation is using the Modified Ashworth Scale because it is a scale that could have subjectivity rather than an objective form of measurement. With this being said, the Modified Ashworth Scale is a widely used tool and was given by the same examiner each time, to try and reduce limitations.

A study by Purohit et al. (2015) referenced under the Gross Motor Function section of this review, found the importance of hippotherapy for improvement in spasticity. In this study, researchers used the Modified Ashworth Scale to measure improvement of spasticity in adductors, hamstring, and plantar flexors, after hippotherapy sessions. The 16 children in this study were 3-10 years old, with a diagnosis of spastic diplegia. Therapy sessions lasted 15 minutes each, were held twice per week and went for 4 weeks. With a significance level of 5% and data analysis through Wilcoxon and Mann Whitney U tests, the researchers found significant improvement in the spasticity of children's muscles after just the 4 weeks of therapy.

Researchers found that while children are riding a horse it eases the strain on their muscles, therefore improving overall movement and muscle usage.

Table 5

Studies of Spasticity

Authors	Participants	Measurement Tools	Findings
Antunes, Pinho, Kleiner, Salazar, Eltz, Oliveira, Cechetti, Gali, & Pagnussat (2016)	- 20 children - Disability: Cerebral Palsy - 5-15 years old	- Modified Ashworth Scale	- Significantly decreased spasticity and reduced muscle tone after just 1 session.
Almendaroglu, Yanikoglu, Oken, Ucan, Ersoz, Koseoglu, & Kapicioglu (2016)	- 16 children - Disability: Cerebral Palsy - 4 years old and older	- Ashworth Scale	- Significantly decreased spasticity in hip adductors.
Purohit, Vyas, & Sheth (2015)	- 16 children - Disability: Spastic Diplegia - 3-10 years old	- Modified Ashworth Scale	- Significant improvement of spasticity in adductors, hamstring, and plantar flexors, after hippotherapy sessions.

Gait

In 2014 Hession et al. conducted a study in Ireland looking for improvement in children's ambulation through hippotherapy. There are 40 children in this study, who are 6 to 15 years old and all have dyspraxia. People with dyspraxia have a hard time organizing and planning their movement because there is a disconnect between the two sides of the cerebral hemisphere. It is thought that "the symmetrical and coordinated movement of the horse is believed to uniformly stimulate both the left and right hemisphere of the human cerebrum" (p. 20); therefore making hippotherapy a great solution to improve the gait of people with dyspraxia.

Before hippotherapy sessions started, children were given assessments including the GAITRite Pressure Mapping System to get baseline scores. A week later, children started 30-minute therapy sessions, which lasted 7 weeks. More assessments were given at the end of the 7 weeks of therapy sessions, to measure improvements made during this time. An analysis was done with Stata Statistical Software (STATA) using paired-samples *t*-tests.

Researchers found that after hippotherapy sessions, the children in this study were able to walk with significantly less support than previously. It also found improvement in the angle of the foot, steps per minute, and a decrease in the amount of time between strides. This study also looked at some other interesting qualitative factors that improved during this study period. Parents also reported, "improvements in self-esteem, confidence, self-worth, self-awareness, anxiety, social skills, focus, empathy toward others, coordination, core stability, flexibility, mood, behavior, and motivation" (p. 21). Hippotherapy seems to be beneficial as an all-around health improvement for the whole person (physical and mental); which can, in turn, improve a child's quality of life.

A limitation of this study is some of the results are qualitative and subjective, such as parent reports about mood, self-worth, and sociability. Although they are measuring those qualitative things, this study is still valid because it also measures many quantitative objective things as well, such as a child's gait as measured through the GAITRite. Researchers used the Childhood Depression Inventory as a more objective tool for measuring children's moods as well. Overall, results found in this study point toward evidence that hippotherapy is a beneficial form of therapy for children with physical disabilities.

A study conducted in Taiwan, in 2017 by Hsieh et al., found the benefits of hippotherapy on various aspects of children's functions. The hypothesis is there would be significant

improvements in body functions, activities, and participation, as measured through the assessment tools, after hippotherapy sessions. There were 14 children used in this study who had cerebral palsy in a range of functioning levels and were between the ages of 3 and 8 years old. The study was conducted as a single-blinded trial with three phases lasting 12 weeks each. The three 12-week phases include: baseline phase, intervention phase, and withdrawal phase. During the 12 weeks of intervention, children received hippotherapy sessions once per week for 30 minutes. The International Classification of Functioning, Disability and Health- Children and Youth (ICF-CY) was used in this study to measure children's functioning abilities.

The ICF-CY assessment was given to children participating in this study at the initial assessment, 12 weeks later as a pre-treatment assessment, 12 weeks later after the therapy sessions, and then again 12 weeks after the therapy sessions had ended as a follow-up to see if the improvements were lasting. The hippotherapy sessions were led by a physical therapist certified in hippotherapy and a registered therapeutic riding instructor through the North American Riding for the Handicapped Association (NARHA). Children rode the horse in a forward position at a walking pace with a 5-minute warm up, 10 minutes walking clockwise, 10 minutes walking counterclockwise, and a 5-minute cool down.

Hsieth et al. (2017) used a Wilcoxon signed-rank test to analyze their data. Researchers found significant improvements after therapy in many categories of functioning, with the biggest improvements in areas of mobility (changing basic body position, fine hand use, hand and arm use, and walking) and neuromusculoskeletal body functions (mobility of joint functions, muscle power functions, muscle tone functions, control of voluntary movement functions, and involuntary movement functions). An interesting approach from this study is researchers conducted a follow-up session three months after the hippotherapy sessions ended, to find if the

improvements gained were lasting. They found there were still significant differences in hand and arm use, and play, at the post treatment follow-up compared to baseline scores. It was found that children with less severe impairments had longer lasting effects of the hippotherapy versus children with more severe impairments. Results from this study suggest that hippotherapy is a useful form of treatment to improve gait, among other things, in children with cerebral palsy.

There are few limitations found in this study. One is that the sample size is quite small, being only 14 children. Another limitation is that on average, children with cerebral palsy usually hit a peak in in their gross motor ability by around age 6; therefore, children after this age may already be declining in their gross motor ability. This could affect scores and results, especially for the older children in this study, since their functioning may be slowly declining. The final limitation is that the ICF-CY is a subjective assessment since it is a checklist, which could produce bias in scores. This was the only tool measuring abilities; there were no objective forms of measurement on children's abilities.

Another study, as referenced previously in the spasticity section, was conducted in Brazil by Antunes et al. (2016). They had hypothesized that hippotherapy would have immediate beneficial effects on both spasticity and gait in children with cerebral palsy. The children used in the study were assessed with a wireless inertial measurement unit (IMU) that was worn on the child's waist to measure spatial-temporal gait parameters. They used a wireless unit is because they wanted to measure how the children walk in a natural environment, such as outdoors, rather than in an indoor laboratory setting. In this study, there were only two therapy sessions, a week apart from each other. Children were assessed before and after each session, in order to see the immediate benefits of just one session riding a horse. The group was split in half where one half did a walk protocol the entire time and the other group did a walk-trot interval throughout the

30-minute session. The next week the two groups switched and did the protocol they had not done the week before.

Data analysis was done through the Mann-Whitney *U* test, paired *t*-test, and the Wilcoxon rank test, with significance level at $a < 0.05$. Researchers measured significant findings in the area of gait performance after children participated in the walk-trot protocol session. Antunes et al. (2016) found an increase in the rolling phase and double support, as well as a significant reduction in the swing phase. The definitions of those phases are as follows: a) the rolling phase is when the ankle rolls toward the ground as body weight is dropped onto the stance foot; b) the double support is the duration of the support phase when both feet are on the ground; and c) the swing phase is an average of the time it takes both the left and right foot to swing from back to front. These findings support the idea that a walk-trot protocol is beneficial to improve gait in children with cerebral palsy, even after just one session.

A limitation of this study includes the small sample size. Ten children were in the study group (with another 10 healthy children in the control group). This is not a very big sample size and may not portray true generalizability to the population. Another limitation is that researchers used a wireless IMU device for children to walk outside in a natural environment. While this is beneficial in simulating a real life setting, it can also cause hindrances to gait measurements, acting as a barrier.

Table 6

Studies of Gait

AUTHORS	PARTICIPANTS	MEASUREMENT TOOLS	FINDINGS
Hession, Eastwood, Watterson, Lehane, Oxley,*& Murphy (2014)	- 40 children - Disability: Dyspraxia - Ages 6-15 years old	- GAITRite Pressure Mapping System	- Significant improvements in amount of support needed for walking, and toe in/out values, cycle time, and cadence
Hsieh, Yang, Sun, Chan, Wang, & Luo (2017)	- 14 children - Disability: Cerebral Palsy - Disability: Cerebral Palsy - 3-8 years old	- Internal Classification of Functioning, Disability and Health-Children and Youth (ICF-CY)	- Significant improvements in ICF-CY qualifiers: changing basic body position, fine hand use, hand and arm use, walking, mobility of joint functions, muscle power functions, muscle tone functions, control of voluntary movement functions, and involuntary movement functions.
Antunes, Pinho, Kleiner, Salazar, Eltz, Oliveira, Cechetti, Gali, & Pagnussat (2016)	- 20 children - 20 children - Disability: Cerebral Palsy - 5-15 years old	- Wireless Inertial measurement units system	- Significant increase in the rolling phase and reduction in the swing phase of gait performance.

Summary of Chapter 2

The articles reviewed in this chapter all show evidence of benefits found through hippotherapy. Hippotherapy can have improvements to a person's overall health and well-being as well as specifically improving gross motor function, balance, spasticity, posture, and gait in children with physical disabilities. These improvements have been found after just one therapy

session and have lasted for up to 12 weeks after therapy sessions ceased. Hippotherapy is a good choice as an alternative type of treatment option, especially for those who have a connection to animals that they may not have with other humans.

Chapter 3: Conclusions and Recommendations

This literature review research examined the physical benefits of hippotherapy on children with physical disabilities. Chapter 1 provided an overview and background of information on hippotherapy. Chapter 2 reviewed studies suggesting hippotherapy is a beneficial form of treatment for children with physical limitations. Chapter 3 summarizes the conclusions and recommendations for future research in the area of hippotherapy.

Conclusions

The 11 studies reviewed in this paper showed physical improvements in children with disabilities who participated in hippotherapy sessions. The specific topics researched are gross motor function, balance, posture, spasticity, and gait. Hippotherapy sessions have been found to benefit children in these areas as well as others including overall well-being and mental health.

Three research studies were reviewed to find the benefit of hippotherapy on Gross Motor Function. Those three studies found hippotherapy sessions beneficial in improving sitting, crawling, kneeling, standing, walking, running, and jumping. Kwon et al. (2015) studied 92 children in Korea who had cerebral palsy. They found improvement after 8 weeks of therapy sessions in sitting, crawling, kneeling, standing, walking, running, and jumping. Purohit, Vyas, and Sheth (2015) used 16 children with spastic diplegia in their study, conducted in India. They found that after relatively short (15 minute) therapy sessions, held twice weekly, for 4 weeks, the children improved in the areas of walking, running, and jumping. The study by Champagne, Corriveau, and Dugas (2017) was done in Canada, with 13 children with cerebral palsy. They found improvements in the children's fine motor precision, balance, and strength, standing, walking, running, and jumping, after 10 weeks of therapy sessions. Researchers also found these results to last for at least 10 weeks after therapy sessions were over. Studies indicate that

hippotherapy is a beneficial form of treatment for improving gross motor functions in children with physical disabilities.

Both of the two studies reviewed on balance showed improvement after hippotherapy sessions. Silkwood-Sherer et al. (2012) conducted a study in the United States with 16 children with various physical disabilities. They found that after 6 weeks of therapy sessions, children had improvements in the areas of single-leg stance, tandem stance, alternating stool touch, and forward reach, as measured by the Pediatric Balance Scale. The study by Kwon et al. (2015) in Korea that researched gross motor function, also found the benefit of hippotherapy on balance in children with cerebral palsy. They found overall scores from the Pediatric Balance Scale to be significantly higher after the 8 weeks of therapy sessions. These studies suggest that hippotherapy treatment will show improvement of balance in children with disabilities.

Posture was another area of improvement shown after hippotherapy sessions, according to the two studies reviewed. Lakomy-Gawryszewska et al. (2017) used an EMG biofeedback device to measure the strength of the abdominal muscles in their study in Poland. After the 3 months of hippotherapy sessions, children's abdominal muscles showed increased strength on the EMG biofeedback device. Increased strength in those muscles leads to greater trunk stability. The other study conducted in Egypt by El-Meniaway and Gehan (2012) also used an impartial tool to measure posture and back geometry in children after hippotherapy sessions. These researchers utilized the Formetric Instrument System to take a three-dimensional scan of the children's back, which was then analyzed through a computer system. They found improvement in children's posture after 12 weeks of therapy, as measured by the degree of impairment of their back geometry. A strength of both of these studies is they use an objective

measuring tool rather than scales or checklists to measure progress in participants. They both indicate hippotherapy is beneficial in improving posture in children with physical disabilities.

Three studies were reviewed finding the benefit of hippotherapy on spasticity in children with cerebral palsy. The study by Alemdaroglu et al. (2016) done in Turkey, reported that through the exercises children participated in while on horseback, as well as the riding itself, produced improvement in spasticity of children with cerebral palsy. Antunes et al. (2016) had found similar results after their study conducted in Brazil. These researchers, however, were also looking at what had biggest improvements, children riding a horse that was walking, or walking and trotting. They found more improvement of spasticity in the children who did the walk-trot protocol session over the children on a horse that was only walking. This study had an interesting angle in that it was looking at immediate effects after just one therapy session rather than after a series of sessions. Another study conducted by Purohit et al. (2015) in India, found improvement of spasticity in children after 4 weeks of hippotherapy. The more flexible muscles are a result of horseback riding, because it eases the strain on their muscles, therefore improving overall movement and muscle usage. Whether it is after just 1 therapy session or a series of weeks of therapy, researchers have found that riding a horse reduces muscle spasticity and causes an increase in overall muscle usage and flexibility.

Three studies found improvement of gait in children after hippotherapy sessions. The first study by Hession et al. (2014) conducted in Ireland, found hippotherapy to improve gait in children with dyspraxia, who have a hard time coordinating their movements due to a disconnect between the right and left side of the brain. Hippotherapy helps with this through the symmetrical rhythm of a walking horse, which may help signals go to both sides of the brain. After 7 weeks of therapy children in this study were able to walk with significantly less support

than previously. It also found improvement in the angle of the foot, steps per minute, and a decrease in the amount of time between strides. This study also looked at what hippotherapy does for overall well-being and found that after therapy, children were happier as measured through improvements in "self-esteem, confidence, self-worth, self-awareness, anxiety, social skills, focus, empathy toward others, coordination, core stability, flexibility, mood, behavior, and motivation" (p. 21). Another study conducted by Hsieh et al. (2017) found improvements of functioning in children with cerebral palsy through their study in Taiwan. After 12 weeks of therapy sessions, researchers found improvements in mobility and neuromusculoskeletal body functions such as mobility of joint functions, muscle power functions, muscle tone functions, control of voluntary movement functions, and involuntary movement functions. This study also conducted a follow up 12 weeks after therapy sessions ceased and found the children with less severe impairments had longer lasting effects of the hippotherapy versus children with more severe impairments. The final study reviewed was conducted by Antunes et al. (2016) in Brazil. They found immediate improvements on children's gait after just one hippotherapy session in the area of gait performance after children participated in the walk-trot protocol session as measured through the wireless inertial measurement unit as children walked in an outdoor natural environment. All three of these studies have found improvement in gait for children with physical disabilities after they have participated in hippotherapy sessions, whether it is just one session or weeks of sessions. They have also found the results to be lasting even after therapy sessions have ended.

Recommendations for Future Research

While hippotherapy has been an idea for thousands of years, it is not a widely used practice in the United States. Of the 11 studies I found, only one of them was conducted in the

United States. This unique form of therapy appears to be more widely used in other countries than in our own. Further research needs to be conducted in the United States in order to inform people of the usefulness of this treatment. Studies from around the world indicate the improvements in the whole self and well-being along with the physical benefits of the individuals who participate in hippotherapy. In order to promote this form of therapy here, more people need to be aware of the benefits.

Another recommendation for future research is conducting studies with bigger sample sizes. Most of the studies I reviewed have very small sample sizes. This could be a result of the strict inclusion and exclusion criteria used to choose participants or the fact that participants (and their parents) must like animals and not be afraid to ride a horse. This type of therapy may be viewed as more dangerous than a traditional form treatment. It is recommended that research should make known that hippotherapy is very safe with the well trained horses and all the extra people used as support to ensure the safety of the rider.

Implications for Practice

I am currently a special education teacher at an elementary school. While hippotherapy probably would not work as a form of therapy to be used during the school day while children are with me, it could however still be beneficial. Children who may participate in hippotherapy sessions outside of the school day can show improvements in many aspects of their life, including performance at school. The five main topics I researched were gross motor, balance, posture, spasticity, and gait. Improvements in these areas can help children at school with getting around the classroom or school building, safety such as on the playground, or even more participation with general education students such as physical education class.

Other areas of a person's life can also be improved through hippotherapy that would carry over to benefit children during the school day. Some of those may include responsibility, social awareness, and self-esteem amongst others. Growth in those skill areas may lead to more focus on school tasks lending itself toward better achievement at school. Hippotherapy is an all-encompassing form of treatment that should be used more often than it is.

Summary

Hippotherapy is a great choice of treatment for children with physical disabilities. It can improve gross motor function, balance, spasticity, posture, and gait, as reviewed in this paper. It can also have benefits for many other areas in the child's life, physically or mentally. This form of therapy may be so effective because children often are able to connect to animals and it is fun to ride a horse; they may be more motivated in doing the therapy activities than with a traditional form of treatment.

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