THE EFFECT OF HIPPOTHERAPY ON BALANCE IN INDIVIDUALS WITH DEVELOPMENTAL DISABILITIES

by

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THE EFFECT OF HIPPOTHERAPY ON BALANCE IN INDIVIDUALS WITH DEVELOPMENTAL DISABILITIES

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ABSTRACT

Hippotherapy is a rehabilitation treatment using the multidimensional movements of a horse as a therapeutic tool to facilitate active gross motor control. The purpose of this study was to examine the effectiveness of a hippotherapy therapeutic intervention on improving balance in individuals with developmental disabilities. This was investigated using performance production measures of the BTrackS portable force plate. Voluntary participants ($n = 10$) with developmental disabilities who ranged in age from seven to thirty-seven years old participated in the study. Measurements were taken before and after a twelve-week hippotherapy intervention program. Balance was quantified by having the individuals stand on the BTrackS force plate for four consecutive 20-second trials. The medial/lateral, anterior/posterior, and ellipse area measurements were analyzed. Following 12-weeks of training, there was a significant increase in balance stability for all participants. Medial-lateral (cm) sway decreased from 0.7 + 0.7 to 0.5 + 1.4 ($p < 0.05$, $d = 0.34$) and anterior-posterior (cm) sway decreased from 0.8 + 0.5 to 0.5 + 0.4 ($p < 0.05$, $d = 0.62$). The results from this study suggest that hippotherapy has a positive influence on balance in individuals with developmental disabilities and can be a useful treatment tool for this population.

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INTRODUCTION

Balance and Fall Risk

Balance is a foundational element for functional and independent movement that can impact safety, mobility, and quality of life. Balance is defined as an even distribution of weight enabling someone to remain upright and steady (Pollock, Durward & Rowe, 1999). It is a highly integrative system, involving visual, somatosensory, vestibular, and musculoskeletal systems, and is essential for upright posture and successfully performing activities of daily living (Pereira, Maia, & de Azevedo Silva, 2012). A steady state of balance requires a prerequisite of postural control. Postural control is defined as the act of maintaining, achieving, or restoring the line of gravity within the base of support (Pollock, Durward & Rowe, 1999). Individuals with deficits in balance and postural control are at a greater risk of fall and injury. Therefore, without balance and postural control, completing basic activities of daily living required for independence becomes incredibly difficult, which leads to greater debilitation and delays (Andò, Baglio, Lombardo. Marletta, & Pergolizzi, 2015).

A balance deficit can lead to an increased number of falls. A fall is "an event that results in a person coming to rest inadvertently on the ground or other level, other than as a consequence of lost consciousness, a violent blow, stroke, or epileptic seizure," (O'Neill, Marsden, Adams, & Silman, 1996). Falls pose a high risk of unintentional injuries, most of which could have been avoided by stronger postural stability and balance (Askham et al., 1990). An increase in falls can lead to increased rates of morbidity and mortality (Speechley, 2011). Morbidity and mortality rates can decrease if an individual has effective balance and reaction stability to avoid frequent falls which cause injury.

Another key component of fall risk is mobility. Mobility can be defined as the "human activity of moving from place to place" and is dependent upon a person's body functions, structures, and capacities (Bussmann & Stam, 1998; World Health Organization, 2001). Mobility is altered when there are balance deficits, which leads to a lower quality of gait, and higher risk for falling (Bartlo & Klein, 2011). In fact, mobility problems have been identified as the most important risk factor for falls, (Speechley, 2011; Tinetti, Speechley, & Ginter, 1988; Verghese, Holtzer, Lipton, & Wang, 2009). Studying balance is especially important for individuals with intellectual disabilities, because they have balance deficits and an increased rate of falls (Jankowicz, Mikolajczyk, Wojtanowski, 2012).

Balance in Individuals with Developmental Disabilities

Developmental disabilities are neurodevelopmental disorders that present in infancy and are characterized by difficulties and delayed development in intellectual understanding of concepts, basic social awareness, and practical problem solving (National Academies of Science, Engineering, and Medicine, 2015). A person has a developmental disability if he or she meets three criteria: 1) IQ is below 70-75; 2) significant deficits in adaptive functioning areas (e.g. conceptual skills, social skills, and practical skills) and; 3) the condition originates before the age of 18 (American Association of Intellectual and Developmental Disabilities, 2013). Common causes of developmental disabilities include genetic conditions, problems during pregnancy, birth complications, childhood injuries or diseases, toxic exposure, and environmental factors (American Association of Intellectual and Developmental Disabilities, 2013). Approximately 1% of the global population has a developmental disability, with 85%, 10%, 4%, and 3% of these individuals having an intellectual disability classified as mild, moderate, severe, and profound, respectively (Maulik, Mascarenhas, Mathers, Dua, & Saxena, 2010; King, Toth, Hodapp, &

Dykens, 2009).

Individuals with developmental disabilities perform more poorly on balance tests compared to a typically developing individual (Blomqvist et. al., 2013). Poor balance in this population is due to sedentary lifestyles, muscle weakness, and a lack of muscle tone that leads to a lack of strength. These deficits lead to poor postural control and contribute to a greater risk of falls (Jelsma, Ferguson, Smits-Engelsman, & Geuze, 2015). Falls and related injuries are a frequent and serious concern for individuals with developmental disabilities (Bray et al., 2002; Cox, Clemson, Stancliffe, Durvasula, & Sherrington, 2010; Enkelaar, Smulders, van Schrojenstein Lantman-de Valk, Weerdesteyn, & Geurts, 2013; Hale, Bray, & Littmann, 2007; Hsieh, Rimmer, & Heller, 2012; Sherrard, Tonge, & Ozanne-Smith, 2001). Not only do individuals with developmental disabilities experience a higher rate of falls compared to the general population but falling leads more often to injury and hospitalization (D. Wang, McDermott, & Sease, 2002; Finlayson, Morrison, Jackson, Mantry, & Cooper, 2010; Sherrard et al., 2001). Possible risk factors for falling in people with developmental disabilities include comorbidities of visual impairments, concurrent medical problems, medication, impaired mobility, high rates of inactivity, and physical declines in balance and strength (Hale et al., 2007; Haveman et al., 2011; Hsieh et al., 2012; Smulders, Enkelaar, Weerdesteyn, Geurts, & van Schrojenstein Lantman-de Valk, 2013; Wagemans & Cluitmans, 2006; Wilgoss et al., 2010). Severity of developmental disability may also play a role in fall risk. Without balance and postural control, completing basic activities of daily living required for independence becomes incredibly difficult, which leads to greater debilitation and delays (Andò, Baglio, Lombardo. Marletta, & Pergolizzi, 2015).

Individuals with developmental disabilities are at an overall greater risk for falls and loss of independence (Jelsma, Ferguson, Smits-Engelsman, & Geuze, 2015). There are training techniques and intervention plans that can improve balance in individuals with developmental disabilities. The therapeutic intervention of hippotherapy is one technique that may improve balance and strength in individuals with developmental disabilities (Giagazoglou et al., 2012).

Hippotherapy

Hippotherapy is a form of animal-assisted therapy that uses the movement of riding a horse to identify underlying impairments, functional limitations, and disabilities, and improve strength, confidence, and independence, (Zadnikar, & Kastrin, 2011). Hippotherapy is a viable modality for improving balance and reducing balance problems associated with individual movement disorders (Silkwood 2012). Hippotherapy takes an interdisciplinary approach by including physicians, occupational therapists, physical therapists, and certified riding instructors to create an individualized treatment plan (All et al., 1999). Therapeutic horseback riding and hippotherapy sessions are performed by Professional Association of Therapeutic Horsemanship International (PATH) certified health professionals in accordance to the treatment plans established by the individual's health care professionals. In order to establish therapy that is safe and effective, the certified therapist is competent in horse and rider pairing. The therapist has the knowledge and skills required to provide patients with quality evaluation, education, and intervention to help them reach their individual therapy goals (Sterba, 2007).

Therapeutic riding and hippotherapy have a beneficial effect on gross motor function and development of postural control in individuals with delays in balance and stability (Stergiou, Tzoufi, Ntzani, Varvarousis, Beris, & Ploumis, 2017). Hippotherapy helps improve symmetrical muscle recruitment patterns, delayed onset activation, and coactivation of muscle groups. Improvement in these areas leads to an increase in postural control and a steadier state of balance

(Silkwood-Sherer, Killian, Long, Martin, 2012). A horse's gait can provide an even, steady, and repetitive movement pattern that is similar to the mechanics of the human gait (Bertoti, 1988). The horse's movement displaces their center of gravity three-dimensionally, which mimics movement of the human pelvis while walking (McGee, Reese, 2009). Throughout the lesson, the rider relaxes into the saddle or bareback pad, and relies on leg adduction and postural righting responses to remain in the center of the horse. These responses lead to increased strength in the rider (Alfredson, Hedberg, Bergström, Nordström, & Lorentzon, 1998). While riding, a rider's muscles and joints adjust to the horse's movement, which, over time, can lead to increased strength and range of motion (McGibbon et al., 2009). The horse's gait generates a variation of locomotion inputs to the rider. These inputs can stimulate the rider and provide an increased strength of muscle contraction, joint stability, and postural righting responses (Miller, 2007). The primary goal of hippotherapy is to improve the individual's balance, posture, mobility, and function (All et al., 1999, McGibbon et al., 2009). Therapeutic riding and hippotherapy have a beneficial effect on gross motor function and development of postural control in individuals with delays in balance and stability development (Stergiou, Tzoufi, Ntzani, Varvarousis, Beris, & Ploumis, 2017).

Hippotherapy sessions vary from week to week to keep the rider engaged and willing to participate (Janura et al., 2009). Sessions include having the horse walk while the rider is mounted. The therapist can instruct the horse and handler to weave in between poles at various distances and speeds to increase and promote a righting response within the rider to remain upright and within the center of the horse while the horse's gait, cadence, and back steadiness vary (Leopore, Yau, 2014). Having the rider reach across his or her midline and grab objects such as rings, balls, and toys or pet the horse at various spots on its neck, promotes axon rebuilding and motor planning skills, which can improve dynamic and static postural stability (Provine, Westerman, 1979). Hippotherapy sessions are uniquely created and developed around the individual's limitations, diagnosis, goals, and ability (Bukowska-Johnson, 2011).

Project Significance

It is important that health professionals monitor balance and fall risk, particularly for individuals with developmental disability, in order to identify those in need of a therapeutic intervention. Participants in this study may improve their balance as a result of hippotherapy. This study could provide more information regarding the use of hippotherapy as a therapeutic modality to improve balance. The results of this study could also lead to a greater understanding of balance among individuals with developmental disabilities.

Purpose and Hypothesis

The purpose of this study was to study the effectiveness of a 12-week hippotherapy therapeutic intervention on balance in individuals with developmental disabilities. Balance was quantified using Balance Tracking Systems (BTrackS) portable force plate. It was hypothesized that hippotherapy is an effective mode of therapy to help individuals with developmental disabilities improve their balance and postural sway.

METHODS

Participants

The participants consisted of 10 individuals with developmental disabilities between the ages of 10 and 25 years, as shown in Table 1. Seven participants were males, and 3 were females. Participants were drawn from the population of individuals at All-Star Equestrian Foundation in Burleson, TX, and individuals participated voluntarily. Individuals who utilize ankle-foot orthotics or assistive mobility devices, such as canes or walkers, were required to complete all tests without the use of these aids. Individuals who were completely reliant on such assistive devices and immobile without the use of them, including individuals who use wheelchairs, were not allowed to participate. In addition, individuals who were unable to fully understand instructions were not allowed to participate. Study procedures were thoroughly explained to participants, who then signed a consent form. If participants were unable to complete a signature, a verbal “yes” or “no” sufficed. For nonverbal individuals, we accepted a head nod or hand sign for “yes” and “no,” along with a legal guardian’s signed permission.

Table 1. Descriptive Statistics of Participants

	N	MINIMUM	MAXIMUM	MEAN
AGE	11	7.0	37.0	17.9 ± 10.2
HEIGHT (IN)	10	49.0	72.0	60.1 ± 6.9
WEIGHT (LBS)	10	62.6	194.0	115.9 ± 41.2
BMI	10	16.7	28.6	22.0 ± 4.0

Instruments

BtrackS Portable Force Plate

The Balance Testing Protocol consists of four 20-second trials, the first two of which is completed with eyes open and the last two with eyes closed as the BtrackS collects data on postural sway by measuring variations in center of pressure. The test requires minimal delays between the trials which begin and end with an auditory tone. The rider will stand as still as possible on the force plate with eyes open or closed, hands on hips, and feet shoulder width apart.

The results are calculated by the BtrackS^{TM} Assess Balance Software (Goble, Manyak, Abdenour, Rauh, & Baweja, 2016).

Procedure

Balance Measurements

After signing consent forms and prior to the hippotherapy intervention, all participants recruited at the All-Star Equestrian Federation completed baseline balance testing. Height was measured using a portable height stadiometer, and weight was measured using a standard scale. Both were measured to the nearest 0.1 inch and 0.1 pound respectively.

The BtrackS portable force plate measured center of pressure at a rate of 25Hz. Center of pressure data produced measures of total sway, anterior-posterior sway, medial-lateral sway, and sway velocity. Balance testing required participants to stand with feet shoulder width apart, hands on hips, and eyes closed for a series of four consecutive 20 second trials. Through these measurements of distribution of center of pressure in both medial-lateral and anterior-posterior dimensions, an ellipsis was created. BtrackS Assess Balance Software was used to objectively determine balance[17] (Goble, Manyak, Abdenour, Rauh, & Baweja, 2016). The Mean Balance Percentile was used to calculate fall risk through the Balance and Fall Risk Protocol (Interpreting BBT Balance and Fall Risk Results, 2017). Individuals were classified as high fall risk, moderate fall risk, or low fall risk. Following baseline testing, participants completed a weekly, one-hour horse riding session for 12 consecutive weeks.

Hippotherapy Lesson

Hippotherapy lessons were uniquely created for each rider by an occupational therapist, physical therapist, and PATH International certified instructor, but typical lessons were similar in process and engagement of rider. A sample hippotherapy lesson is shown in Figure 1. A horse-leader, and two side walkers assisted participants for safety. Participants aided in putting the saddle and bridle on the horse. Riders mounted the horse using a ramp with the assistance of the side walkers. The riders completed a warm-up by walking their horses around the arena. While on the horse, participants engaged in dynamic stretching of the arms and trunk rotation exercises to strengthen their core. Riders would cross over their midline and utilize trunk rotation and flexion to put rings on the horse's neck, pick rings off their own boot, and hand the ring to the side walker at various angles and distances. The last part of the lesson was dedicated to practicing patterns such as figure-8s, pole weaving, and walking over poles to help practice motor planning and righting responses. At the conclusion of the lesson, the riders dismount their horses, and help the side walkers remove the saddle and the bridle from the horses. After completing the 12-week intervention, participants completed the same force plate task for post measurements.

Figure 1 - Sample Hippotherapy Lesson

0-15 Minutes	Mount horse, and warm-up by walking their horses. Depending on their riding skill, they have a horse-leader, and two side walkers who hold onto the rider's legs to help keep them in the center of their saddle.
15-30 Minutes	Dynamic stretching exercises such as anterior arm lifts, posterior arm raises, lateral arm abductions, and then trunk rotation exercises all while walking on the horse. The rider can do these stretches at the best of their ability.
30-45 Minutes	Integrated exercises to help strengthen balance and core. The rider will have plastic rings and practice reaching across their bodies to grab the ring from the side-walkers hand. The rider will then rotate their core and place the ring on the other side-walkers arm. They can then place the rings on the horse's neck or hind end to help with anterior and posterior flexion. Some other exercises include grabbing a plastic egg full of silly putty and try to use fine motor skills to take the objects out of the silly
45-60 Minutes	The rider will practice verbal skills throughout the lesson such as telling the horse to "walk-on," "slow down," or "whoa." The last 15 minutes are dedicated to riding patterns and keeping the rider engaged. They perform figure-8s to help with core stability. They will then dismount their horse and help untack their horses.
Extras	The amount of support that the rider needs is specific to that rider, and the lesson is tailored to them. When untacking a horse, if the individual is strong enough and steady enough to fully untack, then they do so, if not, they help carry the reins.

Statistical Analysis

Once collection was completed, data from the BtrackS Force Plate was downloaded and coded using the BtrackS Assess Balance Software (Goble, Manyak, Abdenour, Rauh, & Baweja, 2016). The Mean Balance Percentile was used to calculate fall risk through the Balance and Fall Risk Protocol (Interpreting BBT Balance and Fall Risk Results, 2017). Balance data was analyzed using the SPSS statistical package. Independent-samples *t* tests allowed for comparisons between the pretreatment and the posttreatment test results. Cohen's *d* was calculated from *t* tests to determine effect size and percent change. Significance was determined at the 0.05 alpha level for all completed tests.

RESULTS

Group statistics were expressed with means and standard deviations as shown in Table 2 and Figure 2. Following the 12 weeks of hippotherapy lessons, all participants significantly decreased overall postural sway from a total distance (cm) of 9.8 ±14.1 to 4.3 ± 6.6 ($p < 0.05$, d = 0.45). Anterior-posterior (cm) sway also decreased from 0.8 ± 0.5 to 1.4 ± 0.4 ($p < 0.05$, d = 0.62). The improvement in balance following the hippotherapy intervention yielded a 51.0 % improvement in minimizing center of pressure distribution. Medial-lateral (cm) sway decreased from 0.7 ± 0.7 to 0.5 ± 0.4 ($p < 0.05$, d = 0.34). This represented a 39.0 % decrease in pressure distribution ellipsis area. Lastly, sway velocity (cm/s) decreased from 4.0 ± 5.4 to 1.9 ± 1.8 ($p < 0.05$), d = 0.56).

Cohen's *d* was calculated to determine effect size, and the hippotherapy intervention had a medium effect size value for anterior-posterior center of pressure, a small effect size for medial-lateral center of pressure, and a medium effect size for balance percentile. These results indicate the significance in the magnitude after the intervention. Overall, balance percentile showed statistically significant results, with a percent change in sway of -42.0 %.

Table 2. Balance Measurement Results from Hippotherapy Intervention

Variable	Pre-	Post-	p	Effect Size	Effect Size Value	% Change
Anterior- Posterior Center of Pressure (cm)	0.80 ± 0.53	0.53 ± 0.36	0.094	0.62	Medium	51.0 %
Medial- Lateral Center of Pressure (cm)	0.67 ± .070	0.49 ± 0.42	0.229	0.34	Small	39.0 %
Percentile	31.0 ± 27.1	53.6 ± 39.2	0.019	0.71	Medium	-42.0 %

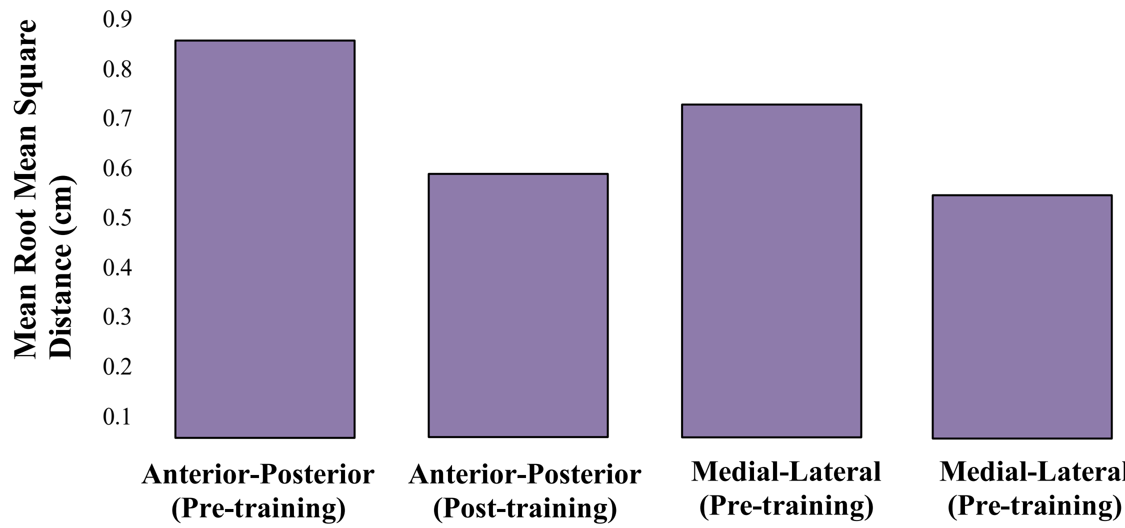

Figure 2. Postural sway distances for pretreatment and posttreatment balance measurements.

Pre- and post- intervention measurements resulted in a decrease in participants' mean balance percentile (Figure 3). The group mean pre- training was classified as a moderate fall risk using the BTrackS Balance and Fall Risk Protocol. Following the hippotherapy intervention, the group mean classified the group as a low fall risk. With a -42 % decrease in fall risk, individuals were able to maintain a steadier base of support, which is a prerequisite for safe and stable ambulation.

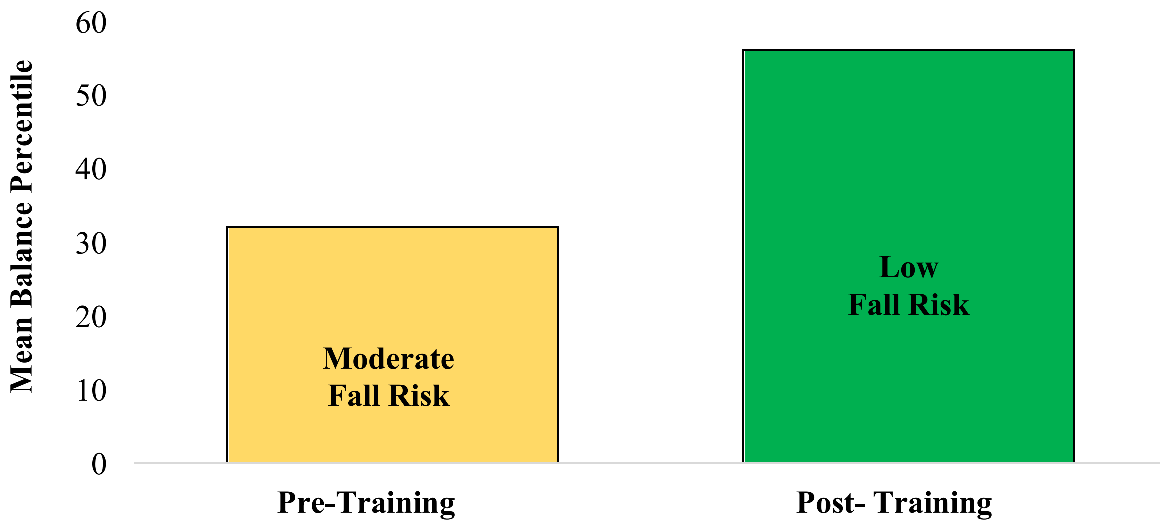

Figure 3. Mean balance percentile and classified fall risk for pretreatment and posttreatment

DISCUSSION

The purpose of this study was to study the effectiveness of a 12-week hippotherapy therapeutic intervention on balance in individuals with developmental disabilities. The results of this study suggest that hippotherapy has a positive effect on balance in children with intellectual disabilities and can be used as a useful treatment tool for this population. An improvement in balance was observed from pre-treatment to post-treatment measurements.

There was a positive correlation between the 12-week hippotherapy intervention program and an improvement in balance in individuals with developmental disabilities.

In order to safely ambulate an environment, an individual must have a steady base of support (Jankowicz-Szymanska, et. al., 2012). Individuals with developmental disabilities and balance deficits distribute their center of pressure medially and laterally as well as anteriorly and posteriorly to remain upright (Goble, et. al., 2018). Based on the measurements from the BTrackS Balance Force Plate, an ellipsis can be drawn and used to calculate balance and fall risk.

Individuals with developmental disabilities perform worse on balance tests compared to typically developing individuals and are at a greater risk for falls and loss of independence (Jelsma, et. al., 2015). Hippotherapy is a unique approach to addressing balance deficits found in individuals with developmental disabilities (Zadnikar, M., & Kastrin, A. (2011). Hippotherapy a form of animal-assisted therapy and is a rehabilitation treatment that uses the multidimensional movements of a horse as a therapeutic tool to facilitate active gross motor control and improve balance (Bukowska-Johnson, 2011).

Following the 12-week hippotherapy intervention, improvements in overall postural sway distance, anterior-posterior sway (cm), medial-lateral sway (cm), and sway velocity occurred as a result of this program. The resulting decrease in anterior-posterior center of pressure distribution (cm) from 0.80 ± 0.53 to 0.53 ± 0.36 revealed a medium effect size, and a 51.0 % change in overall balance. These results show that there was a medium magnitude of effect that occurred during the training protocol. Medial-lateral center of pressure distribution (cm) decreased from 0.67 ± .070 to 0.49 ± 0.42 after training, revealing a small effect size, and a 39.0 % improvement. The most significant finding was the result of the balance percentile change. During pre-treatment data collection, individuals scored in the 31.0 ± 27.1 percentile and during post-treatment data collection, individuals scored in the 53.6 ± 39.2 percentile. These results revealed a medium effect size, and a -42 % change overall. Overall, these findings suggest that a 12-week hippotherapy intervention program has a positive influence on balance in individuals with developmental disabilities.

Using hippotherapy as a treatment tool can greatly benefit individuals with developmental disabilities (McGee, Reese, 2009). Results of this study were similar to previous literature and revealed that a hippotherapy intervention program can strengthen balance in individuals with developmental disabilities, (Giagazoglou, et. al., 2012; Janura, et. al., 2009; Lepore, Yau, 2014; McGee, Reese, 2009). Hippotherapy can improve balance measurements and strength in this population and can be an effective treatment tool to improve balance and functional motor skills (Giagazoglou, et. al., 2012; McGibbon, et. al., 2009). These results may help to advance the use of hippotherapy for improving posture and balance in individuals with developmental disabilities.

Practical Implications

Balance promotes autonomy, involvement in activities, and confidence and is important in all aspects of life. Individuals with developmental disabilities tend to lack the strength and postural control needed to safely navigate their environment (Jelsma et. al., 2015). Utilizing hippotherapy as a therapeutic intervention for individuals with developmental disabilities can improve their balance. In addition to improvements in balance, increases in muscular strength and flexibility can provide the further benefit of creating opportunities for children with developmental disabilities to socialize with others who are experiencing similar challenges. With an increase in balance, strength, and postural control, individuals with developmental disabilities can become more involved in social and recreational activities, (Abells, Burbidge, & Minnes, (2008). When individuals with developmental disabilities become more involved in their community, it adds to a greater sense of self-worth and promotes a healthy relationship with their interacting environment (Kahssay, Oakley, & World Health Organization, 1999). Promoting hippotherapy as a treatment tool for this population, can greatly impact multiple facets of their daily life.

Limitations

A limitation of this study was the sample size. Participants were recruited from All Star Equestrian Federation as a part of their Spring Hippotherapy Session. I had to rely on the belief that each student would attend each session for the 12-weeks of the intervention, attend pre-treatment measurement collection, and be present for post-treatment measurement collection. The post-treatment session was conducted the week after most the participants ended school for summer vacation, so there were a few individuals absent for data collection due to either being on vacation or taking a break. Since I utilized All Star Equestrian Federation, some of their students had been students for years at their facility. For this study, I chose individuals that had either never received hippotherapy, or had a six-month break from their previous session. This also limited my participant population size.

Future Directions

In the future, it will be important for researchers to further study the effects of hippotherapy on balance in individuals with developmental disabilities. In order to do this successfully, future researchers should put an emphasis on a larger sample size in order to observe statistical significance. Throughout my research, I observed that the individuals seemed joyful on the horse and had more confidence after their lessons. Future research can also aim to include other benefits that hippotherapy may offer to individuals with developmental disabilities, such as individual aspects of the lesson that lead to balance development, psychosocial, and emotional development.

APPENDIX

Sample BtracksS Participant Output

BALANCE TRACKING SYSTEMS

BTrackS Balance Test Report: Norms and Fall Risk Assessment

Name: Phil Esposito
ID#: 1
Facility: N/A

The BTrackS Balance Test (BBT) is the standard testing protocol implemented by the BTrackS Assess Balance Software. The BBT result is equal to the average Center of Pressure (COP) Path Length, displayed in centimeters, from three 20-second testing trials. Results relative to others in the same age group are derived from the BTrackS Normative Database which includes 10,000+ results from individuals aged 5-100 years. Fall Risk Assessment (FRA) is made based on the number of standard deviations a BBT result is from the average adult aged 20-39 years.

BTrackS Balance Test (BBT) Results

Baseline	Post-Baseline	% Change
24	N/A	N/A

Comparison to Age Group (30-39yrs)

0 25 50 75 100

Baseline = 44% Post-Baseline = N/A

Fall Risk Assessment (FRA)

LOW: BBT = 0-30
MOD: BBT = 31-38
HIGH: BBT = 39+

Baseline	Post-Baseline
LOW	N/A

The most recent Baseline BBT result has a COP Path Length of 24.

This Baseline BBT result of 24 corresponds to the 44th percentile, meaning this result is better than 43% of similarly aged people.

Based on the BBT result being less than 31, the Fall Risk Assessment is considered LOW.

Baseline BBTs:

TEST DATE	T1	T2	T3	BBT	%	FRA	TEST NOTE
1/17/2017 12:45:31 PM	24	23	25	24	44	LOW	

Post-Baseline BBTs:

TEST DATE	T1	T2	T3	BBT	%	FRA	TEST NOTE

Notes:____

Data Collection Sheet

Assessment

Balance & Postural Control

Name:_______________ DOB:_______________

Participant ID: Age:

Gender: M F Date:

P.I.: Paige Browning Research Assist:____________

Testing Checklist (With Participant)

- _ Explain Study
- _ Signed Consent
- _ Height and Weight
- _ BtrackS
- _ Explain Results

Pre-Measurements

Height (in): _

Weight (lbs): _

NO SHOES, METAL, JEWELRY, ETC.

BtrackS Results: Avg. of all Trials

	Time 1	**Time 2**
95% Ellipse Area		
Mean Velocity (cm/s)		
Mean Distance (cm)		
Mean Frequency (Hz)		
RMS Distance-ML (cm)		
RMS Distance-AP (cm)		
Range-ML (cm)		
Range- AP (cm)		
Approx. Entropy- ML		
Approx. Entropy- AP		

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