Equine Assisted Activities and Therapies: A Case Study of an Older Adult

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ABSTRACT. Falls are the leading cause of injuries and deaths in adults over the age of 65. The purpose of this case study is to explore the use of Equine Assisted Activities and Therapies (EAAT) to improve the mechanisms of balance, postural sway, fear of falling (FOF), and participation in older adults (OA). The participant (a 76-year-old woman), completed 10 Adaptive riding (AR) sessions over a six-week period, led by a Level II therapist (COTA/L and PATH certified riding instructor). Changes in function were assessed using the Berg Balance Scale (BBS), Activities-Specific Balance Confidence Scale (ABC), Activity Card Sort (ACS), and Video Motion Capture (VMC) system. Results indicated improved static standing balance, postural stability, and greater dynamic head and trunk control. Additionally, the participant expressed decreased FOF, decreased back pain, the ability to recover self after a fall, and an increase in activity participation as indicated in the ACS.

KEYWORDS. hippotherapy, adaptive riding, occupational therapy, older adults, equine therapy, treatment

INTRODUCTION

Falls and Older Adults (OA)

With the growing population of older adults (OA) in the United States, attention has been focused on sustaining independence and maintaining healthy living. Twenty-eight to 35% of adults over the age of 65 experience at least one fall per year (Granacher, Wolf, Wehrle, Bridenbaugh, & Kressig, 2010; Hausdorff, Rios, & Edelber, 2001). These falls are the leading cause of injuries and deaths within this population (Center for Disease Control, 2008). Several studies indicated that a fear of falling (FOF) can lead to decreased participation in functional and social activities, a decline in physical strength, decreased independence, and an increase in actual fall risk (Scheffer, Schuurmans, van Dijk, van der Hooft, & de Rooij, 2001).

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Exercise programs for OA have been shown to improve balance and muscle strength while decreasing both FOF and mortality (Gardner, Robertson, & Campbell, 2000). A meta-analysis of exercise-based fall prevention programs indicated that balance training was an important component of effective programs (Sherrington et al., 2008).

**Postural Control in OA**

Postural control may necessitate greater attentional demands in OA than in young adults (Woollacott & Shumway-Cook, 2002). This is particularly true for OA with balance impairment. When these OA are faced with additional attentional demands, postural control may decrease as a result (Shumway-Cook & Woollacott, 2000; Silkwood-Sherer & Warmbier, 2007). Research has shown that OA display slower reaction times during dynamic standing balance, indicating that their attention is focused on maintaining balance and posture (Lajoie & Gallagher, 2004). Moving one’s upper limbs while maintaining static standing balance also requires increased postural control (Elble & Leffler, 2000). As such, OA with balance impairments are especially at risk for falling when simultaneously walking and performing an additional task (Siu, Lugade, Chou, van Donkelaar, & Woollacott, 2008). This is particularly relevant for real life activities such as cooking or reaching for an object which require that a person be balanced to maintain static balance while his/her conscious cognitive control is focused on an upper-extremity task.

Previous research has analyzed balance and stability in OA through analysis of center of pressure (COP) and center of mass (COM) during movement exercises (Lee & Chou, 2006). COP sway path provides information on the participant’s movement during static standing balance. Fournier, et al. (2010) found that the participants in their study with a disability had decreased postural stability compared to control participants without a disability. Lee and Chou (2006) describe their similar findings in COM and COP during gait in OA. Lee and Chou (2006) found that compared to healthy OA, OA with balance disorders have more difficulty controlling COM motion during gait exercises and are more at risk to fall in this plane (Lee & Chou, 2006).

**Equine Assisted Activities and Therapies (EAAT)**

Current fall prevention strategies include various forms of aerobic and muscle-strengthening exercise, designed to challenge and improve participant’s balance and stability (Nelson et al., 2007). However, due to magnitude of current statistics in frequency of falls, additional strategies which incorporate these components are needed to help prevent fall injuries and decreased participation in the OA population.

Equine Assisted Activities and Therapies (EAAT) includes Hippotherapy (HPOT), a treatment by a licensed therapist (PT, OT, or SLP) using the movement of a horse as a therapeutic treatment strategy targeting specific therapeutic goals. EAAT also includes Adaptive Riding (AR), (AKA therapeutic riding) in which a riding instructor who is trained and certified to teach horseback riding to people with disabilities adapts riding lessons to the needs of the individual. EAAT uses the movement of the horse as a kinesio-therapeutic tool to improve the participant’s
muscle strength, body awareness, balance, and coordination (AHA, 2007; Beinotti, Correia, Christofoletti & Borges, 2010). During EAAT sessions, the horse provides a dynamic base of support and challenges these sensorimotor components. The three-dimensional rhythmic reciprocal movements of a walking horse generate normalized pelvic movement of the rider that resemble pelvic movements essential for ambulation (Haehl, Giuliani, & Lewis, 1999). Improvement in trunk stability, posture, and pelvic mobility assist in improved gait and balance (Kwon, et al., 2011). Additional studies have also reported improved postural adaptation to changes in the environment, more effective use of sensory inputs needed to adjust posture and movement, and improved ability to control trunk and head movement (McGibbon, Benda, Duncan, & Silkwood-Sherer, 2009; Shurtleff, Standeven, & Engsberg, 2009).

EAAT may also have several benefits when compared to traditional exercise programs. These include providing an alternative exercise opportunity for people with limited mobility, high compliance due to the recreational nature of the activity, and psychosocial benefits, such as an augmented sense of self efficacy and self esteem (Bizub, Joy, & Davidson, 2003; Bronson, Brewerton, Ong, Palanca, & Sullivan, 2010). Lack of motivation has previously been cited as a barrier for OA to participate in exercise programs aimed at decreasing fall risk. The recreational and social nature of EAAT may be beneficial in motivating participants to attend sessions (De Groot & Fagerstrom, 2011). Previous studies have found that the potential effects of EAAT include improved postural control, motor skills, and stability (Kwon et al., 2011; Shurtleff et al., 2009; Silkwood-Sherer & Warmbier, 2007).

Although EAAT have been used with specific adult populations (stroke, multiple sclerosis), no published study to date has investigated the effects of EAAT on typically aging OA. With the overwhelming need for fall prevention strategies in OA, research in the area of EAAT may expand current prevention strategies and may reduce injuries related to falls. The purpose of this investigation was to explore the use of EAAT approaches in an AR context in improving the mechanisms of balance, postural sway, FOF, and participation in OA. This study contributes to the body of literature on EAAT intervention and how it might facilitate greater participation in daily activities for OA, reduce fall risk, and improve overall quality of life.

**METHODS**

This investigation was designed to recruit 4 OA to participate in group AR sessions. Inclusion criteria included screening for a documented fall risk [score of ≤67% on the Activities-Specific Balance Confidence Scale (ABC)] and a documented fall risk [score of ≤ 46 on the Berg Balance Scale (BBS)]. These scores were previously used as a cut-off score to classify participants as fallers or nonfallers as indicated by Lajoie and Gallagher (2004). Additional inclusion criteria included the ability to independently sit erect, abduct the hips, and the cognitive skills to actively participate in the intervention and follow directions. Individuals were excluded if they had a physician diagnosis of severe sensory impairment (e.g., vision, hearing, vestibular), or any other major neurological or psychiatric conditions. Excluded were also individuals with health conditions included on the Professional Association of
Therapeutic Horsemanship International (PATH) list of precautions and contraindications (PATH International, 2011). Additionally, individuals were excluded if they had any previous HPOT experience, therapeutic or recreational riding experience, or history of riding lessons. The participant’s personal physician must have approved participation. The Human Research Protection Office (HRPO) of Washington University School of Medicine approved the study and the participant signed an approved consent form before beginning testing and AR sessions.

The recruitment plan was to recruit potential participants from local churches and community and senior living centers located in and around Washington, Missouri. Recruitment was focused in and around Washington, Missouri due to the location of the intervention site. Multiple meetings, presentations, and screenings were held to recruit potential participants.

**Procedures And Design**

**Intervention**

AR sessions were led by a Certified Occupational Therapist Assistant trained as a Level II therapist to provide treatment through the American Hippotherapy Association (AHA). She is also certified with PATH as an advanced riding instructor since 1990 and has a MA in Gerontology. The horsehandler and sidewalkers were also experienced instructors and were able to grade the horse movement as requested by the therapist while keeping the participant safe. The horse was selected to meet the needs as well as challenge the participant given her height, weight, balance, and previous lack of riding experience. The intervention plan included 10 weeks of weekly, 45 min sessions at Exceptional Equestrians of the Missouri Valley (EEMV), a PATH premier accredited riding center located in Washington, Missouri. EEMV is a not-for-profit organization that provides EAAT for children and adults with a wide range of disabilities. During the sessions, the participant sat forward astride and did not independently control the horse. It was led by an experienced horse leader and she had sidewalkers to ensure safety. The participant’s personal goal to eventually ride independently was taken into consideration in the development of a training plan using HPOT techniques. The Instructor led the participant in exercises during the sessions, using a variety of school figures, including figure eights, straight lines, weaving around cones, and up and down uneven terrain outdoors. The participant engaged in exercises including reaching in all planes without holding on to the horse. Sessions included speed changes, stopping and starting abruptly, and variations in gait (walking and trotting). These activities and variations were intended to challenge and improve the participant’s balance and stability, in preparation for independent riding, her ultimate goal.

**Outcome Measures**

**Clinical Measures of Balance and Participation**

The ABC and BBS are valid and reliable measures to assess fall risk, providing a predicted probability of falls (Shumway-Cook, Baldwin, Polissar, & Gruber, 1997). Powell and Myers (1995) reported the ABC was a reliable measure in samples of community dwelling OA ($r = 0.92$) and differentiated OA who reported inactivity due to FOF. Research on the OA population with the BBS indicates the measure
has high intrarater and interrater reliability $= 0.98$ (Berg, Maki, Williams et al., 1992; Berg, Wood-Dauphinee, Williams, & Gayton, 1989). Content and criterion validity was established for OA with disability (Berg et al., 1989). Outcome measures were completed pre- and post-intervention. The participant was screened via the ABC Scale for risk of falls. Lajoie and Gallagher (2004) identified the score of 67% on the ABC as a cut-off score to classify fallers from non-fallers. A score of 67% or below indicates fall risk with 84% sensitivity and 87% specificity. ABC is a 16-item questionnaire measuring self-perceived confidence in one’s ability to perform various everyday activities without losing his/her balance or becoming unsteady. The participant rates his/her balance confidence in everyday tasks on a scale of 0% to 100%. The final score is calculated by averaging all responses. Potential participants who demonstrated a documented FOF, as indicated through the ABC, also completed the BBS. Research using the BBS found a cut-off score of 46 could distinguish fallers from non-fallers with value of 82.5% sensitivity and 93% specificity (Lajoie & Gallagher, 2004).

The BBS is a 14-item scale designed to measure balance in OA. Each item is scored from 0–4, 0 indicating the lowest level of functioning and 4 the highest. Total scores can range from 0 to 56. A score of less than 36 indicates close to 100% fall risk, while scores between 41–56 indicate low fall risk (Berg et al., 1989; Berg, Wood-Dauphinee, Williams, & Maki, 1992).

Following the screening, the participant completed a battery of assessments. Dynamic trunk/head stability was tested using a motorized testing barrel and kinematic measurement tools. Participation was assessed using a modified Activity Card Sort (ACS), consisting of a variety of 89 activities (Baum & Edwards, 2001, 2008). The ACS was modified to include questions about intent to reengage in occupations discontinued as well as intent to engage in a broader scope of occupations the individual may not have previously considered. Additionally, the participant and the participant’s family were interviewed about qualitative, subjective changes following intervention including changes in chronic pain, daily activities, and quality of life.

Force plates and Video Motion Capture (VMC) was used to collect COP and COM measurements to determine standing postural control of the participant. Eight VMC cameras (Motion Analysis Corporation, Santa Rosa, CA; using Cortex 1.0) and three force plates (Kistler, Winterthur, Switzerland, 50 cm × 50 cm) in line with the camera’s X-axis were used. The three-dimensional force plates measure ground reaction forces in $X$, $Y$, $Z$ dimension. Once the participant arrived, 25 reflective markers (5 mm) were placed on designated body landmarks (Table 1). Height, weight, and age were also noted. The initial setup trial for force plate and VMC trials was combined by having the participant stand on one force plate (both feet on one marked X on floor) and exhibit some form of movement with applied markers for one second. This formed a kinematic template of the force plate in the Cortex software.

**Postural Stability, Gait Initiation, and Reaction Time Tasks**

Postural stability and gait initiation: Force plate data were collected for 20 s as the force plate captured COP data from the sensors in the plate simultaneously with the cameras capturing COM data from the markers. After 20 s, the participant was
asked to step forward in the direction of the X-axis over the two remaining force plates for analysis of gait initiation. This was repeated for a total of three trials. Before each subsequent trial, the force plates were reset (zeroed).

Reaction time task: Since previous research has found that OA with balance impairments are at a higher risk for falls when performing a secondary task while maintaining stability (Woollacott & Shumway-Cook, 2002), postural stability data was also collected while the participant completed an auditory reaction time test. The same process as the first postural stability task was repeated while the participant stood still for 1 min. The participant was instructed to clap her hands every time she heard an auditory stimulus (the sound of a researcher clapping her own hands). The researcher sat directly behind the participant, out of sight to eliminate the visual cue. The test included 8–9 presentations of the auditory stimulus and was repeated for two trials. Data were separated into two categories: reacting phase, where the participant was actively responding to the auditory stimulus, and anticipatory phase, which was the time between reactions to the stimulus where the participant was cognitively engaged in listening for the stimulus but not moving. This allowed researchers to examine potential changes in postural control both when the participant was cognitively engaged but static (anticipatory phase) as well as cognitively engaged and executing an upper extremity movement (reacting phrase).

**Motorized Barrel Testing**

After completing the static stability test, surface markers were repositioned for the head/trunk dynamic stability tests. A motorized barrel, that was custom designed and built specifically for earlier studies of HPOT for children with cerebral palsy (CP) and developed to mimic the anterior-posterior motion of a horse, was used (Shurtleff & Engsberg, 2010; Shurtleff et al., 2009). The barrel was developed to create a challenge test of trunk and head stability and determines whether EAAT affects the ability to keep the head and trunk stable while the pelvis is in motion, as it also is when someone walks, runs, and jumps (Shurtleff & Engsberg, 2010). The participant sat astride for the dynamic stability tests. Markers were also placed on the barrel to establish a horizontal line representing the laboratory coordinate system. Video data from an 8 Eagle camera HiRes Motion Analysis Corporation VMC system were collected (60 Hz) during the trials. The subject sat astride the barrel for two 15 s trials each at two speeds (0.75 and 1.00 Hz). The barrel moved a fixed distance of 16 cm in each reciprocating movement cycle. Each trial began with the barrel at rest and brought to the testing speed over 2–3 s. Head, trunk, and barrel movement were analyzed using the VMC system. Movement variability, which was defined as the standard deviation of the translation amplitude, was

|-------------------|---------|---------|---------|-----------------------|----------------------|--------------|--------------|------------------|------------------|-----------------|-----------------|
calculated and compared from pre-intervention to post-intervention. The participant was given a small stuffed animal to hold anterior to her abdomen with both hands with shoulders at 0° (abduction/flexion) and elbows flexed to 90°. This discouraged use of a protective extension reflex to assist in maintaining position as the barrel moved. During the testing, the participant was instructed to look straight ahead in order to keep her head stable. Spotters were seated on either side of the barrel as a safety precaution.

**Video Recording of Selected Sessions**

In addition to laboratory analysis, video recording occurred at the first and last intervention sessions to track and compare progress. After recording the session itself the participant, horse leader, and instructor were recorded speaking of the participant’s changes in quality of movement, social behaviors, and response to verbal instructions.

**Data Analysis**

*ABC, BBS, and Modified ACS*

Pre- and postscores were compared for the ABC and BBS. For the modified ACS, a change score was calculated by adding the number of positive answers (do now, do more than I used to, want to do and intend to in the future) and subtracting the number of negative answers (given up due to trouble performing activity, do less than before, want to but do not intend to in the future).

*Force Plates, VMC, and Motorized Barrel Testing*

Force plates and VMC were used to collect COP and COM measurements during standing balance and gait initiation. The force plates were recorded at 300 samples/s with camera data at 60 frames/s. Every 5-force plate samples were averaged and consolidated to 60 frames/s to synchronize force plate and camera data. These data were used to calculate COP and COM displacements, velocities, total sway path length, and total sway path area. Results of standing balance, gait initiation, and motorized barrel testing were entered into Excel for analysis.

Surface marker data from motion capture analysis produced three-dimensional coordinates that replicated the participant’s functional movement cycle. Due to speed transitions during startup of each trial, only the last half (7.5 s or 7–8 movement cycles) of each 15 s trial was used in analysis, after the barrel had reached constant speed. Head angle was calculated comparing the vertex to C7 marker line to the horizontal markers on the barrel. Range of angle change during the test and standard deviation (SD) of angle change were used as key variables to describe movement variability of body segments while being challenged by the movement of the barrel. A smaller range of angles and smaller SD after intervention would indicate increased control of head or trunk in response to the perturbation of the barrel.

Due to the nature of this case study, we did not run statistical analysis as there were no population norms available for the standardized tests to do a two standard deviation band comparison. Data were analyzed looking at percent change, change reported, and movement variability (SD).
RESULTS

During recruitment, many OA at senior and community centers expressed concern about riding a horse at their older age and were not interested in participating. Most individuals at the local YMCA were enthusiastic about participation in the research, but scored between 90%–100% on the ABC screening assessment. This indicated a person who is a low risk for falls, highly functioning, and most likely physically active (Lajoie & Gallagher, 2004; Myers, Fletcher, Myers, & Sherk, 1998). Therefore, they did not demonstrate a FOF, which was an important part of the inclusion criteria.

Due to time constraints and the need to complete AR sessions before they would need to be paused for the winter, we were limited in continuing our recruiting efforts. We were successful in recruiting one OA and decided to do a case study. The participant was a 76-year-old women, who reported the following fall and medical history: infrequent falls (less than once per year) that did not result in injury, body mass index of 39, high blood pressure, high cholesterol, supraventricular tachycardia, and a prior history of breast cancer that was in remission. The participant scored the closest to our ABC screening inclusion criteria with a 71%. Although this score was slightly higher than our idealized range, a score below 80% still indicates an OA whose daily activities are impacted by his/her FOF (Myers, et al., 1998). After completing the screening measures, the participant signed a consent form for participation in the study. The participant completed ten 45-min-EAAT sessions over the course of 6 weeks. Although the original intent was to space these sessions over 10 weeks, with seasonal changes the research team and instructor conducting the intervention completed the sessions in 6 weeks in order to avoid winter weather and the potential of not completing all ten sessions.

ABC, BBS, and Modified ACS

BBS score increased from 47 to 51. ABC score increased from 71.75% to 83.13%. The participant’s change score derived from the modified ACS increased from 38 to 50, an increase of 12 activities either “currently participating in” or “intending to participate in” following the intervention (Table 2).

Force Plates & VMC

Results of COP data showed 12.1% (41.16 cm pre, 36.18 cm post) reduction in COP sway path post-intervention during static standing balance (Table 3). Results of the COM data showed a 36% (19.6 cm pre, 12.6 cm post) reduction in COM sway path post-intervention during static standing balance during the second trial (Table 3; Figure 1). During the “reacting phase” of the reaction test

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Pre</th>
<th>Post</th>
<th>Change Reported</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC (Balance Confidence)</td>
<td>71</td>
<td>83</td>
<td>+12</td>
<td>17%</td>
</tr>
<tr>
<td>BBS (Balance)</td>
<td>47</td>
<td>51</td>
<td>+4</td>
<td>9%</td>
</tr>
<tr>
<td>ACS (Participation)</td>
<td>38</td>
<td>50</td>
<td>+12 activities</td>
<td>NA</td>
</tr>
</tbody>
</table>

Table 2 Results indicate reduced fear of falling, improved balance, and increased participation.
TABLE 3. Size of Decrease in COM/COP Sway Path

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>COP</td>
<td>41.2cm</td>
<td>36.2cm</td>
<td>12%</td>
</tr>
<tr>
<td>COM</td>
<td>19.6cm</td>
<td>12.6cm</td>
<td>36%</td>
</tr>
<tr>
<td>Average COP Area</td>
<td>0.0205</td>
<td>0.0163</td>
<td>20%</td>
</tr>
<tr>
<td>Average COM Area</td>
<td>3.40</td>
<td>2.33</td>
<td>31%</td>
</tr>
</tbody>
</table>

Table 3 Results indicate decrease in COP and COM sway path trial 2 and an overall decrease in COP and COM area from pre to post.

(participant is actively responding to the auditory stimulus) COP sway path length decreased 34.06% (19.06 cm pre, 12.57 cm post) and COM sway path length decreased 31.12% (3.51 cm pre, 2.42 cm post). During the “anticipatory phase” of the reaction test (participant is listening for the auditory stimulus but not moving) COP sway path length decreased 11.78% (46.37 cm pre, 40.91 cm post) and COM sway path length decreased 35.76% (19.61 cm pre, 12.61 cm post). Sway path area decreased 20% from pre-intervention to post-intervention. Additionally, displacement between the COP and COM decreased post-EAAT intervention (Figure 1).

FIGURE 1. COM and COP sway path length pre-EAAT intervention and post-EAAT intervention. This figure depicts the amount of sway (cm) in both the AP and M–L directions. There is approximately 0.5 cm displacement of the COP and COM centroids pre-intervention. Movement of AP and M–L sway (cm) was greatly reduced post-intervention. Additionally, the COP and COM centroids are directly on top of each other post-intervention, indicating, increased stability and control of COP and COM movements.
**Motorized Barrel Testing**

Movement variability (SD) of head to trunk angle did not indicate a notable decrease in movement pre to post. However range (max–min angle) of the head angle in relation to the laboratory coordinate system decreased from 26.7 cm (SD = 5.8) at pretest to 11.0 cm (SD = 2.5) at posttest. Since mean only describes the midpoint of movement and is somewhat meaningless, we chose to focus our attention on Range and Movement variability (SD) as key variables as they were meaningful in describing variation of movement (Figure 2).

**Participant and Therapist Subjective Report**

Midway, toward the end of the intervention, the participant reported that she had experienced a significant decrease in chronic back pain. She rated her back pain prior to intervention at a level of 5/10 with 0 indicating no pain and 10 indicating extreme pain. At midpoint, she rated her pain level at a 0–2/10. In addition, she reported that she experienced less fatigue and no longer had to take daily rest breaks to recover from her chronic back pain. Toward the end of the intervention, she recounted a fall that she recently experienced in her garden in the mud. She reported that she was able to pull herself up with greater stability and confidence than she

![FIGURE 2](image-url). Head Movement pre-EAAT intervention and post-EAAT intervention. This figure shows the angle of the participant’s head at each point in several movement cycles of the barrel testing. The figure depicts the decrease in head angle movement range from 26.7 cm and SD = 5.8 at pretest to 11.0 cm and SD = 2.5 at posttest.
would have been able to do prior to the intervention. She described being able to get up without having to crawl towards the fence and use it for support, whereas when this happened before the intervention she could not get up without pulling herself up, holding onto the fence.

The instructor and other members of the treatment team reported increasing the difficulty of the intervention as it progressed due to the participant’s increased stability. In the first session, the participant used a two-handled surcingle and a western pad, providing a moderate amount of physical support using the upper extremities. By the third session, the participant progressed to using an overgirth which provides less physical support. Additionally, over-the-thigh stability and assistance from sidewalkers decreased to standby assistance as weeks progressed. The team also described the participant as better able to anticipate movement during frequent sudden starts, stops and half-halts by the horse, as directed by the instructor. In addition, the intervention was graded to be more challenging as sessions progressed by increasing the cadence of the horse, the tightness of the patterns, and steepness of the inclines/declines over which the horse walked.

**DISCUSSION**

The purpose of this investigation was to explore the use of EAAT in improving the mechanisms of balance, postural sway, and FOF, toward improving participation in OA. The BBS score increased by 4 points, indicating a trend toward improved functional balance (Hayes & Johnson, 2003; Steffen, Hacker, & Mollinger, 2002). The BBS indicated improvement in balance activities of “turning 360 degrees” and “placing alternate foot on step or stool while standing unsupported.” During the pretest, the participant was able to turn 360 degrees safely, but slowly (5.0 s to the right, 4.2 s to the left). Post-test, the participant demonstrated the ability to turn 360 degrees safely in 3.7 s to the right and 3.6 s to the left, thus scoring the maximum number of points possible on this item. Additionally, the participant improved her speed during the step of alternating task. Prior to the intervention, the participant was able to complete 2–3 alternating steps on a stool with minimal assistance for stability. After the intervention, she demonstrated the ability to complete 18 steps in 20 s, standing independently and safely. These results indicate that the participant improved in speed and coordination in these tasks, skills that are transferable to climbing stairs, ambulation, avoiding obstacles when walking, and surveying one’s surroundings for safety. Increased coordination may decrease attentional demands to posture and stability, expanding one’s ability to attend to these additional tasks.

Decreased participation in activities among OA may be attributed to FOF (Scheffer et al., 2008; Zilistra et al., 2007). The ABC measured our participant’s self-perceived confidence in her ability to perform various everyday activities. The participant’s ABC score increased by 11.4% to a final score 83.1% indicating improved self-confidence in ability to perform daily activities without falling and decreased FOF. Previous literature indicates that a score above 80% is a realistic goal that is achievable through exercise and rehabilitative therapy (Myers et al., 1998). This same study found that scores above 80% were indicative of a community-dwelling OA who was most likely physically active.
One of the most pronounced differences on the ABC was Item #2 (walk up or down stairs) in which participant’s self-rated ability to complete the activity without losing her balance went from only 50% confident at pre-intervention to 80% confident following intervention. The participant’s daughter, with whom she lives, specified during a post session conversation that she noticed her mother was more easily able to navigate stairs and was using the wall less for stability. Her daughter attributed this change to better core strength as a result of regular EAAT. Similarly, for item #15 on the ABC (stepping onto or off an escalator without using your hands) participant responded that she was 20% more confident in her ability to keep her balance while stepping without using hands for support.

This finding is supported by the results of the ACS. Post-intervention, the participant’s change score derived from the modified ACS increased 12 points, which included six fewer negative items (activities in which participant has stopped participating, lessened her participation, or has no interest) and six additional positive items (activities in which participant participates or intends to participate in the future). This indicates that out of the 89 activities contained in the ACS, the participant showed an interest in 12 additional occupations compared to pre-intervention. These findings demonstrate the intentions of our participant to engage in more everyday activities that are instrumental, leisure, and social in nature after the intervention, including attending a yoga class. This increase in activity participation may be attributed to the participant’s increased balance confidence. Her increase in balance and postural stability seen during barrel and static standing balance assessments may have also contributed to this outcome.

The participant described that the decrease in chronic lower back pain resulted in less daily rest breaks, making it easier to participate in physical activities such as EAAT and aquatic exercise. Similarly her daughter stated, “I believe [EAAT] gives her confidence and variety in her activities.” Her daughter also attributed several psychosocial benefits to the intervention, such as enjoyment of time-spent horseback riding and participating in EAAT. Based on these perceptions, along with physical benefits, the participant’s daughter and other family members arranged for the participant to continue in private therapeutic riding lessons as a Christmas gift.

The results seen in these clinical measures are supported by the kinematic data. As indicated by Fournier et al. (2010), COP sway path can provide information on the participant’s static standing balance. The 12.1% decrease in COP Sway Path length during the static standing phase indicates improved static postural control and balance with less extraneous movement. Lee and Chou’s (2006) similar findings of COM and COP during gait indicated that improvement in these areas may decrease the risk of falls. Our participant’s decrease in COP sway path indicates an increase in postural stability post-EAAT intervention that could lead to greater functional stability and decreased fall risk. It is not clear why we did not also see a reaction in COM Sway Path Length through all three trials during this test. A 36% change was reported during the second trial, but not noted during trials one and three. This could be attributed to the fact that the participant’s initial COM Sway Path Length was notably shorter than her initial COP Sway Path Length, indicating greater initial stability and less potential for improvement. Increase in postural control was also indicated by the COM and COP centroids. As
indicated by Figure 1, center of COM and COP as indicated by the centroids, were displaced prior to the intervention. Post-intervention, the centroids are on top of one another, indicating more postural stability as the COM is held over a more stable base of support.

The 34.06% decrease in COP Sway Path length and the 31.12% decrease COM Sway Path Length during the “reacting” phase (clapping hands in response to an auditory stimulus) of the reaction time test shows improved postural control and balance while moving the upper extremities and being cognitively engaged in a task. Similarly, the 12% decrease in COP Sway Path Length and 36% decrease in the COM Sway Path Length during the “anticipatory” phase (listening and waiting for the auditory stimulus), shows improved postural control while standing physically still but being cognitively engaged. Previous research (Elble & Leffler, 2000; Shumway-Cook & Woollacott, 2000), suggests that following intervention the participant requires less attentional resources in order to maintain postural control. As such, she may be better able to maintain her balance while engaged in a cognitive task or anticipating voluntary upper extremity movements (such as reaching for an object) because she does not have to devote as much attention to stabilizing her balance.

The results of the motorized barrel testing support previous research on the effects of EAAT techniques in improving trunk and head stability during sitting (Bertoti, 1988; Shurtleff et al., 2009). Decreased angular movement of the head and trunk during the barrel testing indicates that the participant had improved head control following the EAAT intervention. Reductions in head to barrel angular movements indicated the participant increased control of head movements to reduce movement variability by 50% during the barrel test. Head control is particularly relevant since the vision and vestibular senses which are resident in the head provide much of the sensory input that regulates balance. Previous research with OA and adults with impaired nervous systems has indicated that postural control becomes more difficult and requires more conscious control when less sensory information is available (Silkwood-Sherer & Warmbier, 2007; Teasdale, Bard, LaRue, & Fleury, 1993). Therefore, if the participant’s head is stable and he/she is able to more readily receive visual and vestibular inputs, postural stability may also improve and require less conscious cognitive control. Better head control, as measured through motorized barrel testing, was also seen in studies of children with CP following hippotherapy intervention (Shurtleff et al., 2009; Shurtleff & Engsb erg, 2010). This study is the first to assess the validity of motorized barrel testing with the OA population. Results show that this may be a valid test to use with OA to assess dynamic stability. Future research may expand on its use and effectiveness with this population.

EAAT challenges postural control through the horse’s variable, rhythmic, and repetitive movements (AHA, 2007). These movements prompt motor learning to occur and lead to improved functional performance (Shumway-Cook & Woolacott, 2001). As indicated in previous research, EAAT provides the rider with movement input that resembles pelvic movements essential for ambulation (Haehl et al., 1999). Improvements in pelvic mobility, trunk stability, and posture lead to improved gait and balance (Haehl et al., 1999). Improved head and trunk control will transfer to functional ambulation in that our participant may have
more head control while scanning her surroundings while ambulating, providing more awareness of hazards that could potentially lead to falls.

Through administration of the ABC, we found that many of the participants in exercise programs such as water aerobics and “Silver Sneaker” programs had a ceiling effect. During recruitment for this study, we found that many OA participating in these exercise programs were willing and interested in participating in this research study. We believe, this indicates that such programs are of interest and may be beneficial for the OA population in maintaining health and maintaining or improving balance confidence as indicated by their high scores on the ABC. This study has identified EAAT as another possible alternative to traditional exercise programs. These activities provide OA with a tool to increase balance, postural stability, increase confidence, and decrease risk of falls, as well as increase participation in occupations which they value.

**Limitations**

Due to recruiting challenges, this study is limited to a case study of one OA’s intervention experience. Future research with a larger group of OA would provide valuable information as to how others may respond to the intervention. It may also allow a control group for comparison of results with statistical tests of significant change. Future research may also focus on finding better ways to recruit OA who have balance that is impaired enough to necessitate intervention, but who are safe enough and confident enough to participate in EAAT. Another limitation to this study was the short duration of the intervention. Future research may look at the effects of a longer intervention and the effects of varying dosage of EAAT.

The participant was also physically active prior to the intervention, as she attended water aerobics at the YMCA one to two times per week. The potential effects of this additional exercise are unknown. Her activity level as seen through the ACS and anecdotal evidence may have affected her performance and her response may not be typical of other OA. However, as seen through our results, we did see improvements in FOF, balance, activity participation, and overall postural stability after the intervention even though the participant was previously an active individual.

Another limitation to the study was the lack of follow-up assessment. Future studies may benefit from doing assessments at 6 months and 1 year follow-up to address the carry-over effect of the intervention in activity participation and fall risk. Additionally, funding to provide transportation for OA who have given up driving could help eliminate a major barrier to participation for many potential participants.

**CONCLUSIONS**

The purpose of this investigation was to explore the use of EAAT techniques to improve the mechanisms of balance, postural sway, FOF, and participation in OA. Stability of the head and trunk improved and the participant demonstrated a decrease in postural sway. The participant also indicated an increase in balance confidence post-intervention and identified an increase in actual and anticipated activity participation on the ACS. The results from this pilot study suggest that EAAT may
be a valid set of intervention tools to be used with the OA population and may improve balance, postural support, and reduce FOF. Improvement in these areas may contribute to increased activity participation and improve quality of life. Further research on the use of EAAT with OA is needed to verify its use as a set of effective treatment approaches with this population.

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DECLARATION OF INTEREST

The authors report no conflict of interest. The authors alone are responsible for the content and writing of this paper.

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