EFFECTS OF SIMULATED HORSEBACK RIDING ON BALANCE AND QUALITY OF LIFE IN OLDER ADULTS WITH PARKINSON'S DISEASE

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DEDICATION

To my biggest fan, supporter and companion in life, my husband, Lee Goudy.

Without you my world would be vanilla.

"Talent is God given. Be humble.
Fame is man given. Be grateful.
Conceit is self-given. Be careful."

- John Wooden

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ABSTRACT

LEAH GOUDY

EFFECTS OF SIMULATED HORSEBACK RIDING ON BALANCE AND QUALITY OF LIFE IN OLDER ADULTS WITH PARKINSON'S DISEASE

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Parkinson's disease (PD) is characterized as a chronic, progressive movement disorder. Motor symptoms may include posture and balance dysfunction. Non-motor symptoms may include changes in cognition, sleep patterns, and mood. Any combination of these symptoms can impact quality of life (QoL). Horseback riding may be an effective modality to slow the progression of symptoms in those with PD. The use of a simulator can be a cost-effective option to horseback riding in a therapeutic setting. The purpose of this investigation was to determine changes in balance and QoL following 6 weeks of simulated horseback riding (SHBR) in older adults diagnosed with PD. Purposive sampling was used to recruit 10 older adults with PD, 40 to 80 years of age, from across northern Texas. Participants completed a 6-week SHBR intervention that consisted of two, 60-min riding sessions per week. Aspects of postural sway, static and dynamic balance, and QoL were measured 6 weeks before, 1-week before, and immediately after the intervention. Pre-intervention dynamic balance scores were significantly lower than baseline scores (25.86 ± 4.36 vs. 28.25 ± 3.81; $p = .001$). Total balance scores at pre-intervention were also lower than baseline (45.86 ± 6.42 vs. 48.36 ± 5.97;

$p = .050$), and were increased at post-intervention when compared to pre-intervention (50.00 ± 4.38 vs. 45.88 ± 6.42; $p = .002$). No significant differences across time points were reported for measurements of postural sway, including reaction time and directional control. Only the cognitive impairment dimension of QoL exhibited statistical significance, as post-intervention scores were lower than baseline (21.5 ± 14.4 vs. 37.5 ± 20.5; $p = .007$). Six weeks of simulated horseback riding may significantly improve overall balance and cognitive impairment in older adults with PD.

Keywords: Parkinson's disease, balance, static, dynamic, SHBR, QoL, falls, exercise

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CHAPTER I

INTRODUCTION

Parkinson's disease (PD), originally known as shaking palsy, is an idiopathic, progressive, and chronic neurodegenerative disorder affecting physical and emotional health (Goodwin, Richards, Taylor, Taylor, & Campbell, 2008). The disease is caused by a reduction in dopamine, a hormone that plays a key role with movement integration, mood, and motivation (Borta & Höglinger, 2007).

The prevalence of PD is approximately one million individuals in the United States, with 60,000 new cases diagnosed each year (Parkinson's Foundation, 2018). The primary symptoms of PD are rigidity and motor disturbances, including bradykinesia, akinesia, and hypokinesia (Dibble, Addison, & Papa, 2009). Rigidity, or increased muscle tone in the arms or legs, often presents unilaterally and continues to manifest asymmetrically, and may contribute to postural deformities (Parkinson's Foundation, 2018). Bradykinesia is the slowness in the performance of movement sequences, and is the most common of movement disorders affecting approximately 80% of those diagnosed with PD (Morris, 2000). Akinesia is difficulty initiating movement, including freezing or hesitation (Morris, 2000). Hypokinesia is a decreased amplitude of movement and includes reduced trunk rotation, short steps, and minimal arm swing, typically impacting one side of the body more than the other (Morris, 2000).

These primary symptoms and conditions may impact static and dynamic balance. The normal aging process typically involves changes within the sensory system leading to a disruption in the control of balance, causing greater risks of falls in healthy older adults (Tinetti, Speechley, & Ginter, 1988). This is primarily due to multiple changes in neuromuscular structures and their functions that may lead to impaired motor performance (Remaud, Thuong-Cong, & Bilodeau, 2016). Combining the conditions of healthy older adults and those with PD, along with the well-documented difficulties in transfers, posture, balance and walking, static and dynamic balance are critical aspects of PD (Karaa, Genca, Colakoglub, & Cakmurb, 2012). Additionally, individuals with PD may exhibit a deficit in maintaining equilibrium during quiet stance and gait initiation, termination, or turning (Karaa et al., 2012).

Abnormal balance and dysfunctional gait, a result of the inherent pathophysiology of PD, are among the leading risk of falls in this population (Schlick et al., 2016). Based on the National Institutes of Health, compromised postural stability and gait disturbances increase the risk of falls by 40 to 70% in those with PD (Shen, Yu, & Mak, 2016). Falls can cause physical injury and have negative psychological effects, leading to an inability to efficiently perform daily activities (Shen et al., 2016). Traditional exercise may result in improvements in postural stability and balance task performance in individuals diagnosed with PD, mitigating potential falls (Dibble, Addison, & Papa, 2009).

According the American Heart Association, exercise may delay or prevent chronic illnesses and diseases associated with aging, and maintain quality of life (QoL) and independence for seniors (Nelson et al., 2007). Exercise is widely beneficial to individuals with PD, including maintaining or improving QoL (e.g., active daily living, social aspects), reducing the severity of symptoms, and improving functional capabilities (de Goede, Keus, Kwakkel, & Wagenaar, 2001; Kendrick et al., 2014; Howe, Skelton, & Ballinger, 2011). Strength and balance training may also positively influence perceived QoL in individuals with PD (Deslandes et al., 2009).

Alternative modalities of exercise may also elicit improvements in balance and mobility in individuals with PD. These programs include non-contact boxing (Combs et al., 2011), tai chi (Hackney & Earhart, 2008), and tango dancing (Hackney, Kantorovich, Levin, & Earhart, 2007). Some other methods of alternative exercise that have gained more recent attention among researchers are equine-assisted activities and therapies (EAAT).

In 1969, the North American Riding for Handicapped Association (NARHA) was formed. Today, it is known as the Professional Association of Therapeutic Horsemanship (PATH) International. The initial focus of PATH International was on physical and mental therapy, and since has evolved into a multitude of different equine-related purposes, collectively known as EAAT (PATH International, 2018). Equine-assisted activities and therapies include therapeutic horseback riding and hippotherapy (Rigby & Grandjean, 2016). Equine-assisted activities (EAA), formerly known as therapeutic horseback riding (THR), involves the teaching of specific riding skills to individuals with a variety of disabilities by non-licensed professionals (PATH International, 2018).

Equine-assisted therapies (EAT), formerly known as hippotherapy, requires the involvement of certified physical, occupational and speech therapists who employ various techniques, including the use of the rhythmic movement of the horse, to improve the functional ability and perceived QoL in individuals with disabilities (Millhouse-Flourie, 2004).

Individuals of all ages and abilities can experience physical and emotional benefits from horseback riding. The three-dimensional, rhythmic movements of a walking horse generates movement at the rider's pelvis that resemble movements essential for ambulation (Fleck, 1992; Garner & Rigby, 2015). With this rhythmic movement, riders often experience physical adaptations, including improvements in balance and muscle strength (PATH International, 2018).

Horseback riding as a therapeutic technique has been used in older adults who are otherwise healthy (de Araujo et al., 2013; de Araujo, Silva, Costa, Pereira, & Safons, 2011) and in adults with a variety of disabilities such as multiple sclerosis (MS; Silkwood-Sherer & Warmbier, 2007), spinal cord injury (SCI; Lechner, Feldhaus, Gudmundsen, Hegemann, Zach, & Knecht, 2003), stroke (Beinotti, Correia, Christofoletti, & Borges, 2010) and cerebral palsy (CP; Debuse, Gibb, & Chandler, 2009). Significant improvements in balance using the Fullerton Advanced Balance Scale (Rose, Lucchese, & Wiersma, 2006) have been reported in healthy older adults after 8 weeks of EAA performed 60 min per week (Homnick, Henning, Swain, & Homnick, 2013). The results from an unpublished pilot study included increased reaction time in older adults after 4 weeks of EAA performed 120 min per week (Goudy, Silliman-French, Rigby, & Avalos, 2017). In individuals with MS, statistically significant improvements in balance were reported following 10 weeks of EAT performed once per week for 30 min (Hammer et al., 2005). After 12 months of EAA, improvements in balance and muscle strength were observed in adults with SCIs (Asselin, Penning, Ramanujam, Neri, & Ward, 2012). In post-stroke patients, statistically significant improvements in balance and lower limb movement were reported following 16 weeks of EAT performed three times per week (Beinotti et al., 2010). In another study, a 63-year-old individual with CP self-reported a decrease in fear of falling and a reduction in the incidence of falls after EAT (Debuse et al., 2009).

Although EAAT has associated physical and mental benefits, simulated horseback riding (SHBR) may accurately reproduce the movements of a horse in a controlled setting (Rigby, Papadakis, Bane, Park, & Grandjean, 2015). Individuals utilizing SHBR can facilitate balance control through the replicated movement of the simulator (Kim & Lee, 2015). The use of a simulator has numerous advantages, including freedom from space limitations, affordability, easiness of handling, not being affected by weather conditions (Borges, Werneck, Silva, Gandolfi, & Pratesi, 2011), and reducing the risk of falls that are associated with horseback riding (Carrillo, Varnagy, Bragg, Levy, & Riordan, 2007). Simulated horseback riding is also an available option for those with allergies to horses or those who are fearful of horses (Wuang, Wang, Huang, & Su, 2010).

The use of SHBR was previously reported as improving physical abilities, such as static balance and dynamic balance function, walking ability, and posture in healthy seniors (Mitani et al., 2008). Kim, Yuk, and Gak (2013) reported a decrease in postural sway and improvement of dynamic balance after 8 weeks of SHBR in seniors. Kang (2015) reported that after SHBR, elderly individuals significantly improved their scores on clinical assessments of balance and gait, including the Berg Balance Scale (BBS; Berg, Wood-Dauphinee, Williams, & Maki, 1992) and the Timed Up and Go (TUG) Test (Podsiadlo & Richardson, 1991).

Conceptual Framework

The conceptual framework suited for this investigation was derived from the concept of quality of life (QoL) and will be discussed in the following section.

Quality of Life

The QoL conceptual model development began in 1991 by the Centre of Health Promotion in response to a specific request from the Ontario Ministry of Community and Social Services. A model and instrumentation to assess QoL in individuals with developmental disabilities was created (see Figure 1). Since the completion of the QoL model in 1994, the model has been implemented with success and was reported to accommodate all persons, with or without disabilities. The model was further tested for relevance and was refined through a rigorous review of both adults and adolescents with and without physical disabilities, and older adults living in the community. The final

being	***who one is***
Physical Being	• physical health • personal hygiene • nutrition • exercise • grooming and clothing • general physical appearance
Psychological Being	• psychological health and adjustment • cognitions • feelings • self-esteem, self-concept, and self-control
Spiritual Being	• personal values • personal standards of conduct • spiritual beliefs

belonging	***connections with one's environments***
Physical Belonging	• home • workplace/school • neighborhood • community
Social Belonging	• intimate others • family • friends • co-workers • neighborhood and community
Community Belonging	• adequate income • health and social services • employment • educational programs • recreational programs • community events and activities

becoming	***achieving personal goals, hopes, and aspirations***
Practical Becoming	• domestic activities • paid work • school or volunteer activities • seeing to health or social needs
Leisure Becoming	• activities that promote relaxation and stress reduction
Growth Becoming	• activities that promote the maintenance or improvement of knowledge and skills • adapting to change

Figure 1. Quality of Life Research Unit, QoL Conceptual Model (1994).

product is a model that is multidimensional and assumes QoL is holistic in nature, or considers the person as a whole (Renwick, 2014).

The QoL conceptual model defines QoL as ". . . the degree which a person enjoys the important possibilities of his or her life" (Quality of Life Research Unit, 2018). The QoL profile includes the components and determining factors of health and well-being that aligns with the philosophy of the World Health Organization (WHO). The QoL Profile includes the individuals' physical, psychological, and spiritual functioning, their connection with their environment, and their exposure to opportunities for maintaining and improving skills.

The QoL conceptual framework includes three domains with three sub-domains in each. An individual's QoL includes the domains of being, belonging and becoming, with respective sub-domains measured with two factors: importance and enjoyment. Therefore, QoL is based on the importance of meaning attached to each domain and to what extent the individuals' enjoyment is in relation to each domain (Renwick, 2014).

Purpose of the Study

To date, there are no known studies that have included SHBR as a technique for maintaining or improving symptoms (e.g., tremors), the skills necessary for daily living (e.g., balance), or QoL in those diagnosed with PD. Therefore, the purpose of this investigation was to determine the changes in balance (i.e., static, dynamic) and QoL following 6 weeks of SHBR in older adults diagnosed with PD.

Hypotheses

Based on the quantitative nature of this investigation, there will be three null hypotheses tested using a level of significance set at $p < .05$ and the three research questions are:

1. There will be no difference in dynamic balance before and after SHBR on the BearBack in individuals with PD.
2. There will be no difference in static balance before and after SHBR on the BearBack in individuals with PD.
3. There will be no effect on perceived QoL from SHBR on the BearBack in individuals with PD.

Research Questions

1. Will the BearBack simulated horse-riding program improve static and dynamic balance in individuals with PD?
2. Will a simulated horse-riding program increase the perceived QoL in individuals with PD?

Delimitations

Participants:

1. With Parkinson's disease.
2. Who are self-ambulatory?
3. Who can participate two times per week for 8 weeks?
4. Who are free of any surgical procedures in the past 6 months?

5. Who are older adults; male and female ages 50 to 80 years of age.
6. Who have a signed, formal, written physician's note?
7. Who are without medically diagnosed dementia?
8. Who are novices to horseback riding?
9. Who are a maximum of 120 kilograms of weight.
10. Who are between a minimum of 155 cm and maximum of 185 cm of height?

Environment:

1. Free of external noise and distraction
2. Designated area for intervention
3. Two assistants to prevent potential falls of participant

Definition of Terms

The following terms and definitions are essential to the purpose of this study:

1. Akinesia: Difficulty initiating movement, also known as freezing (Parkinson's Foundation, 2017).
2. Bradykinesia: Slowness of motion. Individual's movements become increasingly slow and over time muscles may randomly freeze (Parkinson's Foundation, 2017).
3. Dynamic balance: Maintaining equilibrium when moving from point to point (Gallahue, Ozmun, & Goodway, 2012).
4. Dyskinesia: Difficulty or distortion in performing voluntary movements (Michael J. Fox Foundation for Parkinson's Research, 2018).

5. Hypokinesia: Decreased amplitude of movement, expressionless, mask-like face, and walk with reduced trunk rotation, short steps, and minimal arm swing, impacting one side of the body more than the other (Parkinson's Foundation, 2017).
6. *Neurocom Balance Master*: Mechanical device that provides objective assessments of sensory and voluntary motor control of balance with visual biofeedback.
7. Parkinson's disease (PD): Chronic progressive neurodegenerative disorder of insidious onset, characterized by the presence of predominantly motor symptomatology (e.g., bradykinesia, rest tremor, rigidity, and postural disturbances). It is also associated with a diversity of non-motor symptoms, which, together with late-onset motor symptoms (e.g., postural instability and falls, freezing of gait, speech, swallowing difficulties), are presently one of the most difficult challenges the treating physician is faced with when dealing with patients with a long duration of the disease (World Health Organization, 2016).
8. *Parkinson's Disease Questionnaire-39*: Thirty-nine item self-report questionnaires, which assess Parkinson's disease-specific health related quality (Hagell & Nilsson, 2009).
9. Parkinsonism: Generic descriptive term that refers to the whole category of neurological diseases that causes slowness of movement (Parkinson's Foundation, 2017).
10. Postural instability: Impairment in balance and coordination (Parkinson's Foundation, 2017).

11. Rigidity: Stiffness of the arms or legs beyond what would result from normal aging or arthritic changes. Rigidity often presents unilaterally and continues to manifest asymmetrically, contributing to the postural deformities (Parkinson's Foundation, 2017).
12. Simulated horse-riding program: Mechanical device that can accurately reproduces the movements of a horse by activating muscles of postural stability (Kim, Her, & Ko, 2014).
13. Static balance: Maintaining equilibrium in a controlled stationary position (Gallahue, Ozmun, & Goodway, 2012).
14. Quality of life: Broad multidimensional concept that usually includes subjective evaluations of both positive and negative aspects of life (Centers for Disease Control and Prevention, 2017).

CHAPTER II

REVIEW OF LITERATURE

Keywords: Parkinson's disease, balance, static, dynamic, SHBR, QoL, falls, exercise

Researchers continue to explore methods to improve balance and QoL in individuals with PD. Balance impairment is a primary symptom of individuals with PD and has direct implications to QoL. For instance, this may lead to a greater risk of falls which could potentially limit the ability to live a productive life. Adaptions to exercise can improve balance, decrease the incidence of falls, and improve the QoL for individuals diagnosed with PD.

According to the National Institute on Aging (2011), by the year 2020, society will have more older adults (i.e., aged 65 or older) than ever before due to increased life expectancy. Since aging is a known risk factor for Parkinson's disease, researchers are focusing on improving the potential negative effects of the aging process and QoL. An aspect of the aging process is a reduction in sensorimotor systems (e.g., vision, touch, vestibular, proprioception), which may affect balance. Therefore, improving balance should be a primary goal for individuals with PD. Increasing balance using exercise in individuals with PD may provide a viable treatment to prevent falls and improve QoL

The purpose of this investigation was determine the changes in balance (i.e., static, dynamic) and QoL following 6 weeks of SHBR in older adults diagnosed with PD.

Static balance, dynamic balance, and QoL were assessed before and after a control phase (i.e., no simulated horseback riding) and an intervention phase.

Based on the purpose of this investigation, this chapter was organized using the Adapted Physical Activity Taxonomy (APAT; Carano, 2014) to critically review the following topics: (a) balance and falls, (b) balance and exercise, (c) exercise and QoL, and (d) equine assisted-activities and therapies (EAAT) and simulated horseback riding (SHBR). The investigator reviewed literature to guide and support the current investigation to determine if SHBR may increase balance and QoL in older adults with PD.

Potentially relevant articles, published between 1992 and 2017, were identified through selected: (a) electronic search engines, (b) texts and journals, and (c) reference lists in articles specifically downloaded from the search engines. These methods were used to conduct the literature review searches. Further, the publication dates selected were based on the review of the reference list from the initial relevant article search.

The following indexing systems and search engines were used to identify and locate relevant research articles related to the purpose of this investigation: SPORTDiscus, ProQuest Nursing, Science Direct, ERIC, Ovid MEDLINE, PubMed, Google Scholar, and PsycINFO. Keywords used for the electronic searches included "Parkinson's disease," "Parkinsonism," "Hoehn and Yahr Scale," "neurodegenerative disease," "simulated horseback riding program," "equine assisted activities and therapies," "EAAT," "balance," "static balance," "dynamic balance," "instability," "falls," "bradykinesia," "quality of life," and "shaking palsy." Each term was further reviewed using a thesaurus to determine additional potential connections to each term. The search was limited to full-text access and English language journals published within the last 25 years. The 25-year timeline was based on additional literature within the reference lists of initial relevant articles.

Adapted Physical Activity Taxonomy

The APAT was developed to provide a professional format in which research articles can be rigorously evaluated within the field of adapted physical activity. Further, the APAT format involves four types of research designs which have their own recommended criteria: (a) experimental/quasi-experimental design, (b) single subject design, (c) correlational design, and (d) qualitative design. The APAT is comprised of two parts: (a) review for quality and (b) review for level of recommendation. Implementing this two-part review, the investigator can provide a systematic assessment of research in the field related to the present dissertation study. Data were provided at the end of this section to evaluate the selected texts, journals, and reference lists in articles as a group within the section. Tables containing taxonomy evaluations of literature identified in this chapter are located in Appendix A. The tables within the appendix were sorted by headings and numbered by the research article. Each taxonomy evaluation followed the reference and include the Level (L) of the study and the Table (T) number linked to the specific study (e.g., Rigby & Grandjean, 2016) [L2; T1].

Quality of Strength of Study

The APAT was used throughout this review of literature to determine the quality of each individual study and the strength of recommendation based on the evidence presented in the article. There are three levels of recommendation, which are: (a) Level I (i.e., strong study), (b) Level II (i.e., moderate study), and (c) Level III (i.e., weak study). Each section of the article was evaluated for quality. Further, the APAT is divided into four separate scales, which correspond to the four research types. The current review of literature was comprised of the following: 13.6% (n = 3) of Level 1 studies, 4.6% (n = 1) of Level 2 studies, and 81.8% (n = 18) of Level 3 studies.

Level of Recommendation

Part 2 of the APAT is used to determine the level of recommendation for each research study and the relationship to the current research study. There are three levels of recommendation. A recommendation of Level A can be made if one of the following criteria are met: (a) results of the study hold significant value and can be applied to multiple settings related to adapted physical activity, (b) consistent findings were reported using randomized trials or through the use of a systematic review, or (c) interventions were validated and relevant to populations, including individuals with disabilities. A recommendation of Level B is reached when evidence-based recommendations provide direct benefit for individuals with disabilities. These recommendations are not based on opinion or field-based experiences, and do not provide a significant outcome that can be applied to educational, recreational, or disability sport settings. Level B recommendations include limited or inconsistent evidence relating to adapted physical activity. A recommendation of Level C includes studies with recommendations based on opinion, consensus, practice or field-based experiences, or studies that do not include some benefit to individuals with disabilities through physical activity. The current review of literature is composed of the following: 81.8% (*n* = 18) of Level A studies, none at Level B, and 18.2% (*n* = 4) of Level C studies.

Implications for Older Adults with Parkinson's Disease

Older adults with PD may display a variety of symptoms unique to the individual. However, as PD is classically defined as a movement disorder, there are some commonalities between PD and the normal aging process (e.g., gait disturbance, postural instability). In addition to motor symptoms, there are also non-motor symptoms that are often poorly recognized and inadequately treated (Chaudhuri, Healy, & Schapira, 2006) [L3; T1]. These often-overlooked features may include depression, sleep disorders, and psychosis, all of which may be significant factors when assessing QoL (Chaudhuri et al., 2006). These attributes of PD along with various exercise modalities were specifically searched in the following review of literature, and were organized as follows: (a) balance and falls, (b) balance and exercise, (c) exercise and QoL, and (d) EAAT and SHBR, in older adults with PD.

Falls Related to Static and Dynamic Balance Dysfunction

The risk of falls are common in older adults, and significantly contribute to morbidity, mortality, and premature nursing home admissions (Wehofer, Goodson, &

Shurtleff, 2013) [L3; T2]. Falls are more prevalent in older adults diagnosed with PD when compared to older adults without PD (Gray & Hildebrand, 2000) [L3; T3]. Of the primary symptoms of PD, postural instability and gait disturbances directly impact balance and are among the leading risk factors for falls in this population (Schlick et al., 2016) [L3; T4], increasing the risk of falls by 40 to 70% (Shen et al., 2016) [L3; T5].

Bloem, Grimbergen, Cramer, Willemsen, and Zwinderman (2001) [L3; T6] reported that individuals with PD typically have an underlying balance disorder causing the majority of falls. These same authors conducted a study that included 59 individuals with PD and 55 age-matched controls. Both groups had a mean age of 61 years. Balance and gait were evaluated using the Tinetti Balance Assessment Tool (Tinetti et al., 1988), Retropulsion Test (Fahn, Marsden, Calne, & Goldstein, 1987), and the Romberg Test (ScienceDirect, 2018). Participants were then placed into two groups (i.e., recurrent fallers, non-recurrent fallers) based on the results of a questionnaire. The type of fall circumstances were also divided into two groups: intrinsic (i.e., age related; vision, balance, gait) and extrinsic (i.e., environmental; footwear, physical environment, carpeting, uneven surfaces). Based on the results 70% of falls were intrinsic for individuals with PD. The researchers concluded that the strategies used to prevent falls in individuals with PD should be developed to account for intrinsic factors, which include balance.

In a prospective longitudinal study conducted by Georgy, Barnsley, and Chellappa (2012) [L2; T7], 15 participants with PD and a mean age of 76 years attended a 90-min exercise therapy session that included the use of a standardized mat and a chair-based exercise program. The mat portion of the program included the participant performing the following lying supine on a mat: a neck roll, pelvic tilt, knee opening, knee lift, leg stretch, arm reach, and a combination of arm and leg reaching. In the chair portion of the program, participants sat with an erect posture in a chair, straightening the neck and back while inhaling, slumping backward into a chair, rounding the shoulders and neck, and dropping the head forward while exhaling.

Participants also completed a movement strategy training session (e.g., walking with cuing and attention strategy training) to assess improvements in gait, reduction of gait freezing, and fall risk reduction. Participants attended the program once per week for 90 min during the first year and once biweekly for 90 min during the second year. Outcome measures were assessed at baseline, at one year and at 2 years after the study began. Measures included a self-report of falls, New Freezing of Gait Questionnaire (Giladi, Shabtai, Simon, Biran, & Korczyn, 2000), Tinetti Balance Assessment Tool (Tinetti, 1988), and Parkinson's Disease Questionnaire-39 (PDQ-39; Jenkinson, Fitzpatrick, Peto, Greenhall, & Hyman, 1997). These researchers concluded that a combination of regular exercise and movement strategy training has the potential for reducing risk of falls, improving balance, functional capacity, and QoL in people with PD.

Static and Dynamic Balance and Exercise

Given that falls are among the most common features of PD (Bloem et al., 2001), more research is needed to determine feasible and viable modes of exercise to potentially enhance balance and QoL in individuals with PD (Crizzle & Newhouse, 2006). A variety of exercises may be beneficial to those with PD. Given the unique attributes of PD, the exercise modality needs to be designed to meet the needs and safety of the individual. A wide variety of effective interventions to improve balance in individuals with PD can be located in recent research (e.g., Gobbi et al., 2009) [L3; T8].

In an investigation by Gobbi et al. (2009), two exercise programs were performed by individuals with PD. There were thirty-four participants with a mean age of 67 years, ranging from Stage I to Stage III on the Hoehn & Yahr Scale (Hoehn & Yahr, 1967), divided into two groups. Group 1 (n = 21) was assigned to a multi-mode exercise program designed to develop functional capacity (i.e., aerobic, flexibility, strength, motor coordination and balance). The multi-mode exercise program included rhythmic activities, callisthenic gymnastics, stretching exercises, and recreational activities for 6 months, 3 times per week, 60 min per session. Every 12 sessions, the intensity progressively increased. Group 2 (n = 13) was assigned to a program used to alter the effects of inactivity through exercise related to flexibility, strength, motor coordination and balance. Participants in group 2 exercised for 6 months, once per week, 60 min per session. The intensity did not increase throughout the program in this group. The BBS and the TUG Test were used at pretest and posttesting. There was no difference in the prescribed exercise intensity between the groups. Both groups improved their mobility and balance from pretest to posttest.

Another example of an alternative mode of exercise for those with PD was identified in a study conducted by Hackney and Earhart (2008) [L3; T9]. There were 33 participants with PD, between the ages of 51 to 73 years, randomly assigned to either an experimental group or a control group. The experimental group participated in 20, 1 hr sessions of Tai Chi for 10 to 13 weeks. The control group received no intervention. The experimental group improved more than the control group with various assessments of balance, including the BBS, Unified Parkinson's Disease Rating Scale (Fahn, Marsden, Calne, & Goldstein, 1987), TUG Test, Romberg Test, Six-Min Walk (Balke, 1963), and backward walking using a timing mat. It was concluded that using Tai Chi as an exercise modality has positive results related to gait, balance, and functional mobility in those with PD.

Exercise and Quality of Life

Researchers have reported that " . . . given the progressive nature of PD, and the relatively short duration of uncomplicated medication effectiveness, it is critical to identify interventions that minimize related impairments while maximizing QoL" (Dibble, Hale, Marcus, Gerber, & LaStayo, 2009, p. 752) [L1; T10]. To minimize symptom severity in those with PD while maximizing QoL, exercise has been suggested as an appropriate intervention. In a study conducted by Dibble, Marcus et al. (2009), 20 individuals with PD between the ages of 40 and 85 years were equally distributed into an experimental group or control group. Both groups performed standard exercises (i.e., stretching, walking on a treadmill, arm ergometry) and resistance exercises (i.e., machine and free weights) using the upper extremities for a period of 12 weeks, 3 times per week for 45 to 60 min per session. The experimental group also performed high-intensity eccentric exercise training using a leg ergometer. Quality of life was measured using the *PDQ-39*. There were significant improvements in isometric muscle force, bradykinesia, and QoL in the exercise group. It was concluded that high-intensity, eccentric resistance training may elicit improved mobility and QoL in persons with mild to moderate PD.

When considering the factors that impact QoL in people with PD, the ability to efficiently perform activities of daily living (ADLs; e.g., bathing, dressing, work, homemaking) should be considered. In an investigation by Rodrigues de Paula, Fuscaldi, Salmela, Coelho de Morais Faria, Rocha de Brito, & Cardoso (2006) [L3; T11], 20 individuals with PD with a mean age of 61 years participated in 12 weeks of aerobic conditioning and muscular strengthening, 3 sessions per week, for 75 min per session. Quality of life was measured using the Nottingham Health Profile (NHP), a 38-item self-reporting questionnaire. Significant improvements were reported for the total NHP percentages by categories, including social interaction (41.1%), emotional reaction (21.1%), energy level (19.1%), physical ability (14%), sleep level (9.5%), and pain level (8.1%). Further, regular exercise can improve emotional health and should be considered as a means for increasing QoL in those with PD.

In another study, polestriding exercise was performed with older adults diagnosed with PD (Baatile, Langbein, Weaver, Maloney, & Jost, 2000) [L3; T12]. This pretest and posttest quasi-experimental design included administering the UPDRS and the PDQ-39. There were six male participants, between the ages of 40 to 70 years, all performed polestriding exercise for 8 weeks, 3 times per week for up to 60 min per session. A significant improvement was reported with scores on the UPDRS and PDQ-39 (Baatile et al., 2000).

Equine-Assisted Activities and Therapies and Simulated Horseback Riding

The use of EAAT as a therapeutic strategy has been studied in those with some form of cerebral palsy (CP; Rigby, Gloeckner, Sessums, Lanning, & Grandjean, 2017) [L1; T13], Down syndrome (Champagne & Dugas, 2010) [L3; T14], multiple sclerosis (Menezes, Copetti, Wiest, Trevisan, & Silveira, 2013) [L3; T15], spinal cord injury (Lechner et al., 2003) [L3; T16], stroke (Beinotti et al., 2010) [L3; T17], autism spectrum disorder (Wuang et al., 2010) [L3; T18], intellectual disabilities (Giagazoglou, Arabatzi, Dipla, Liga, & Kellis, 2012) [L3; T19], and developmental delays (Thompson, Ketcham, & Hall, 2014) [L3; T20]. Although improvements in dynamic and static balance in individuals with specific disabilities (e.g., CP, Debuse et al., 2009 [L3; T21]; autism spectrum disorder, Wuang et al., 2010; Down syndrome, Champagne & Dugas, 2010) after EAAT have been reported, there have been no known studies completed to date that have included measurements of balance following an EAAT intervention in individuals diagnosed with PD.

In a therapeutic setting, the movement of the horse is thought to improve the rider's muscle strength, body awareness, balance, and coordination (Beinotti et al., 2010). Further, improvements in gait, balance, posture, and range-of-motion after 8 weeks of EAAT were anecdotally reported in children with cerebral palsy (Rigby et al., 2017).

In a study conducted by Araujo, Silva, Costa, Pereira, and Safons (2011) [L3; T22], 17 adults between the ages of 60 to 84 years were randomly assigned to either an experimental group (*n* = 7) or a control group (*n* = 10). The experimental group included 2 males and 5 females, while the control group consisted of all females. The experimental group participated in 30-min sessions of EAAT, biweekly for 8 weeks. The control group received no intervention and was not involved in any regular physical activity. The TUG Test and stabilometry force plates were used to assess balance before and after the intervention period. There was no significant difference in either group in the analyzed stabilometric parameters. There was a significant improvement in the scores on the TUG Test after 8 weeks of EAAT in the experimental group.

Homnick et al. (2013) [L3; T23] conducted a study to determine if EAAT improved balance and QoL in community-dwelling older adults with balance deficits. The participants were 5 females and 4 males, between the ages of 71 to 83 years, who underwent a protocol in the following order: an 8-week control period, an 8-week EAAT program performed once per week for 60 min per session, and an 8-week follow-up period. At the start of the study and at weeks 8, 16, and 24, balance testing was conducted using the Fullerton Advanced Balance Scale (Rose, 2006). Quality of life was measured at weeks 8 and 16 using the Rand Short Form 36 Quality of Life Measure (Ware, 1992). There was no significant change in balance scores during the first control period (0 to 8 weeks). There was a significant improvement in balance scores from the start to the end of the EAAT intervention (8 to 16 weeks), but no significant difference between the end of the EAAT intervention and the end of the follow-up period (16 to 24 weeks). Finally, most measures of QoL improved from the beginning to the end of the intervention, but only the measure of perception of general health reached statistical significance.

It is well documented that exercise and EAAT can reduce the risk of falls and improve balance. However, it has not been determined if the use of SHBR can lead to similar adaptations in individuals with PD. The use of a simulated saddle may elicit many of the same physical benefits as an actual horse (Wuang et al., 2010), allowing SHBR to be a viable intervention for individuals with PD with noticeable balance deficits.

Simulated Horseback Riding

Simulated horseback riding may be an effective intervention for improving balance in the elderly (Kim & Lee, 2015) [L3; T24] and with those who have had a stroke (Kim et al., 2014) [L3; T25]. However, few studies have included the use of SHBR as an intervention to improve balance in older adults. To date, no study has included SHBR as an intervention with individuals diagnosed with PD.

In a recent study, Kang (2015) recruited 20 participants who were randomly assigned to an experimental group (n = 10; mean age: 70.1 years; 7 male, 3 female) or a control group (n = 10; mean age: 71.2 years; 6 male, 7 female). The experimental group performed SHBR for 6 weeks, 5 times per week for 15 min per session, and the control group performed single-limb standing exercise for 6 weeks, 5 times per week for 15 min per session. Significant improvements were observed with the BBS and the TUG Test in the experimental group, while the control group showed no significant improvement in either assessment after 6 weeks (Kang, 2015) [L3; T26].

Other researchers conducted a study using SHBR to investigate changes in trunk balance and gait in chronic stroke patients (Kim et al., 2014). There were twenty participants with a mean age of 63.9 years that performed SHBR for 6 weeks, 5 times per week for 30 min per session. The Trunk Impairment Scale (TIS) was used to measure static and dynamic balance while seated, the Bio-Rescue (a mechanical device that uses force plates to measure Limits of Stability [LOS]) was used to assess balance, and the Functional Gait Assessment (FGA) and a timing mat were used to measure spatiotemporal parameters of gait. A significant decrease occurred in movement (i.e., sway area, sway distance, sway velocity) according to the TIS. Significant improvements were also observed in gait velocity, cadence, stride length, and time in double limb support.

Researchers have also investigated the effects of SHBR on muscle activation and LOS in older adults (Kim & Lee, 2015). There were thirty elderly adults randomly divided into an experimental group (n = 15) and a control group (n = 15). All participants were over the age of 65 years. The experimental group performed SHBR for 8 weeks, 5 times per week for 20 min per session. The control group underwent a similar protocol, but received conventional therapy. Electromyography was used to measure muscle activation and the Bio-rescue was used to measure LOS. After the intervention, sway significantly increased in all directions (i.e., front, front-right, right, back-right, back,

back-left, left, front-left) in the experimental group while no change was observed in the control group. Muscle activation in measured muscle groups (i.e., rectus abdominis, erector spinae, quadratus lumborum, external oblique, gluteus medius) increased significantly in the experimental group but no increase in activation was observed in the control group.

Summary

Currently there are more than 850 Professional Association of Therapeutic Horsemanship International centers, aiding over 66,000 children and adults with some form of disability (Professional Association of Therapeutic Horsemanship [PATH] International, 2018). Due to the increasing need for centers that are PATH-accredited, recent fundraising campaigns have been undertaken to help service the thousands of individuals with disabilities on a waiting list at a given center (PATH International, 2018). This further supports the need for SHBR as a potentially effective alternative for these individuals. Given the physical limitations and inherent pathophysiology of PD, researchers should consider the use of SHBR as a viable alternative to more traditional therapeutic modalities to increase balance, potentially reducing risk of falls, and increasing QoL in this population. The results of this present investigation may contribute to the existing body of literature regarding the benefits of EAAT, with the intention of broadening the scope to include SHBR as an alternative to improve balance and QoL in individuals with PD.

The APAT analyses of the articles reviewed within this chapter pertaining to the Level of Strength were as follows: (a) 13.6% (n = 3) of Level 1 studies, (b) 4.6% (n = 1) of Level 2 studies, and (c) 81.8% (n = 18) of Level 3 studies. In addition, the Level of Recommendation was (a) 81.8% (n = 18) of Level A studies and (b) 18.2% (n = 4) of Level C studies. The relevant article terms used for the search engines were as follows: (a) 54.5% (n = 12) included Parkinson's disease, (b) 72.7% (n = 16) included Balance, (c) 54.5% (n = 12) included Dynamic, (d) 22.7% (n = 5) included Static, (e) 36.3% (n = 8) included Simulated Horseback Riding, (f) 36.3% (n = 8) included Quality of Life, (g) 31.8% (n = 7) included Falls, and (h) 59% (n = 13) included Exercise. In conclusion, the articles reviewed for this investigation indicate a limited amount of available research related specifically to the effects of SHBR on balance and QoL in older adults with PD.

CHAPTER III

METHOD

Participants

There were twelve participants, ages 40 to 80 years with a diagnosis of PD or Parkinsonism recruited through purposive sampling. The participants were recruited through Seniors-in-Motion (Denton, TX), a health and fitness program within a structured framework of a group setting. After an initial email, flyers were sent. The investigator attended a monthly meeting to formally introduce the study, answered any potential questions regarding the recruitment email, and provided potential recruits the opportunity to express interest or concerns.

The participants were screened to include those who were: (a) ambulatory with or without assisted devices, (b) free from any surgical procedures performed within the last 6 months, (c) without orthopedic problems that could be exacerbated by exercise, (d) without any known cardiovascular, pulmonary or metabolic disease, and (e) comfortable with sitting on a simulated saddle 2 sessions per week, 60 min per session. Exclusion criteria were: (a) a classification of Stage 5 (i.e., wheelchair user, bedridden unless aided) on the Hoehn and Yahr Scale, (b) regular horseback riding experience (i.e., > 60 min per week) within the last 2 years, and (c) currently taking additional medication that may affect exercise performance, with the exception of medication specifically used for PD treatment (e.g., Carbidopa-levodopa).

Experimental Procedure Overview

Prior to the start of this research study, the required Institutional Review Board (IRB) process was followed. All necessary paperwork was filed and approved prior to data collection by the Texas Woman's University's (TWU) IRB for research involving human participants (see Appendix B). Once receipt of the IRB approval was obtained, the investigator attended a monthly meeting at Seniors-in-Motion to begin the recruitment process.

All participants attended a preliminary visit before the study began. This visit included an overview of the study (i.e., timeline, time commitment, intervention, location). All experimental data were collected before and after each phase (see Table 1). The two phases in this study each had a duration of 6 weeks. A familiarization period, held before the intervention, had a duration of 1 week and was used to acclimate participants to the simulated saddle and all protocols. The order of the phases were as follows: (a) a control phase (i.e., no riding occurred), (b) a familiarization period, and (c) an intervention phase (i.e., simulated horseback riding [SHBR]).

Preliminary Visit

An initial screening took place at Pioneer Hall, room 123 at TWU for all participants. At this time, participants were screened and introduced to the study protocol and all of the equipment used in the study. Participants read and signed a university-approved informed consent (see Appendix C), photo-video release form, and a medical history questionnaire to allow for participation in the study. Participants were encouraged to

Table 1

Study Timeline

Testing Session	Control Phase	Testing Session	Familiarization Period	Intervention Phase	Testing Session
	6 weeks No intervention		1-week 1 session 60 min session	6 weeks 2 sessions per week 60 min per session	

voice any questions or concerns related to the study. At the conclusion of the preliminary visit, the participants were asked to wear comfortable clothing to all testing sessions and were informed that bottled water would be provided if needed.

Testing Sessions

The testing sessions took place in Pioneer Hall, room 123 at TWU. Prior to all testing sessions, the protocol and all procedures were reviewed and the participant was re-assented (i.e., provided verbal affirmation of his/her willingness to participate). To begin, body weight and height was measured using the Detecto Stadiometer (Detecto, Model 339). The participant then performed a quantitative dynamic balance test, a clinical assessment of static and dynamic balance, and finally a QoL questionnaire.

The Limits of Stability (LOS) test, performed on the Neurocom Balance Master (Neurocom International, Clockamas, OR), was used to assess dynamic balance (see Appendix D). The *Balance Master* has dual force plates connected to a computer that traces the horizontal movement of the center-of-pressure of the feet. A visual monitor at eye level allowed the participant to have a visual target and real time performance input. For the test, each participant independently performed 8 tasks involving a directional leaning/balance protocol (i.e., front, front-right, right, back-right, back, back-left, left, front-left).

Static and dynamic balance were also assessed using the Berg Balance Scale (Berg, 1992; see Appendix E). This test was developed to measure balance in older adults. This test consists of a 14-item scale that typically takes 15 to 20 min for completion with a point scale of 1 to 56. A cut off score of 45 has been suggested for fall risk (Berg et al., 1992).

Quality of life was measured using the PDQ-39 (Jenkinson et al., 1997; see Appendix F). This self-report questionnaire measures the impact of daily living within relationships, social situations and communication in individuals with PD during the previous 30 days.

Familiarization Session

A familiarization session took place between phases at Pioneer hall, room 119 for all participants for 60 min (see Table 1). During this session, participants were acquainted with the simulated horseback riding saddle (BearBack, Chariot Innovations, Waco, TX) by sitting on the device while not moving for 10 min (see Appendix G). The BearBack was then turned on by the primary investigator at the lowest frequency (i.e., 30 Hz) for 10 min. Participants verbally stated if they were comfortable.

Intervention

All participants then completed an intervention phase. This phase included SHBR training using the BearBack. The intervention phase lasted 6 weeks, with each SHBR session performed 2 times per week, 60 min per session with at least a 48-hr rest period between each session. The intervention sessions took place in Pioneer Hall, room 119, at TWU in Denton, TX.

During each SHBR session, the participants exercised at a moderate intensity. To ensure this intensity was reached, a 5 to 6 level on the modified Rate of Perceived Exertion (RPE) scale was reached. As a secondary measure, a wireless heart rate (HR) monitor (Polar Electro Inc., Lake Success, NY) was placed around the participant's chest to measure heart rate reserve. The equation for HRR is:

$$\textit{Target HR (THR)} = [(HR_{max} - HR_{rest}) \times \textit{\% intensity desired}] + HR_{rest}$$

Resting HR was assessed in a seated position on a saddle after 5 min of sitting quietly at each session. After resting data were collected, the participant was asked to exercise on the saddle for 60 cumulative min. The exercise was split into multiple 15 min bouts if needed. While on the saddle, the participant was asked to maintain an erect posture, keeping the head, shoulders, and hips centered over the saddle, with the feet placed at the side of the simulated saddle.

Statistical Analyses

The Statistical Package for the Social Sciences (SPSS v.23) for Windows was used to determine the outcomes of SHBR training. The independent variable was time (i.e., baseline, pre-intervention, post-intervention). The dependent variables were reaction time (RT) and directional control (DCL) from the LOS protocol, scores from the BBS (i.e., total, static, dynamic), and the percentage score in each of the 8 levels of the *PDQ-39*.

A repeated measures (RM) multivariate analysis of variance (MANOVA) was used to test the main effect of time (i.e., baseline, pre-intervention, post-intervention) for the composite score for each of the LOS variables (i.e., RT, DC). Another RM MANOVA was conducted on the combination of the total, dynamic, and static balance scores for the BBS. For each of these analyses, significant main effects of time were followed up with univariate tests on each dependent variable. Finally, 8 separate RM ANOVAs were conducted on the PDQ-39 for each of the 8 dimensions for the quality of life scale. Sidak *post hoc* tests were used to determine which time points differed from each other whenever a significant main effect of time was detected in the univariate analyses. Where violations of sphericity occurred, Greenhouse-Geisser adjusted values were reported. The alpha level for all analyses was set at 0.05.

CHAPTER IV

RESULTS

The purpose of this investigation was to determine the changes in balance (i.e., static, dynamic) and QoL after 6 weeks of SHBR in older adults diagnosed with PD. The BBS was used to measure static and dynamic balance. The Neurocom Balance Master (Neurocom International, Clockamas, OR) was used to measure dynamic balance using the LOS test on 8 leaning tasks. These measures were compared at the beginning and end of the 6-week control phase and at the end of the 6-week SHBR intervention phase for each participant. The PDQ-39 was used to assess perceived QoL in older adults with PD. Data for QoL were measured at the beginning of the control phase and at the end of the intervention phase. The use of a repeated measures design was used to determine the outcomes from each phase. In this chapter, the results will be presented in the following order: (a) Participants, (b) Inter-Rater Reliability, (c) Test Results, and (d) Summary.

Participants

A total of 12 adults, ages 61 to 81 years with a diagnosis of PD or Parkinsonism, were purposefully selected for this investigation. Before data collection, 3 potential participants withdrew from the investigation. Reasons for withdrawal were a torn meniscus, transportation issues, and inability to control blood pressure. Although 9 participants completed the investigation, 1 participant was excluded from this investigation because he was diagnosed with Meniere's disease during the intervention, which affected his balance (i.e., static, dynamic). Therefore, the final data of 4 males and 4 females were analyzed. Participant demographic information is presented in Table 2.

Table 2

Participant Demographics

Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Diagnosis Onset (years)
69.3 ± 6.0	160.5 ± 21.0	82.0 ± 22.7	32.2 ± 8.3	5.2 ± 2.6

Note. Values are presented as mean ± SD. BMI = Body Mass Index.

Inter-Rater Reliability

In order to maintain internal reliability and decrease the probability of experimental bias for this study, agreement for inter-rater reliability was established (see Table 3). Inter-rater reliability for the BBS was calculated between the same two raters for all participants throughout the baseline, pre-intervention, and post-intervention phases. After the completion of each measurement, the raters compared their scores for each test item. In instances of disagreement, the test item in question was reviewed by comparing notes taken during each testing session, and discussed until an inter-rater agreement of 100% was reached. To statistically confirm the reliability of the raters, a Cronbach's alpha was conducted including the inter-item correlation. This resulted in a high correlation α coefficient (≥ .8) for Cronbach's alpha, and a highly reliable α coefficient for inter-item correlation of (≥ .9).

Table 3

Inter-Rater Reliability

	Baseline	Pre-Intervention	Post-Intervention
Cronbach's Alpha	.961†	.948†	.983†
Inter-Item Correlation	.943*	.902*	.972*

Note. † Highly reliable ≥ .9. * Highly correlated ≥ .8 between raters.

Test Results

Of the 8 participants, 6 were able to complete all SHBR individual sessions continuously for 60 min. Only one participant requested to stop briefly for 5 min in two different sessions to stretch his legs, then continued with the intervention. Another participant requested to stop during one session due to excessive tremors that impeded his ability to ride safely. Once hydrated and properly stretched after 5 min, he was able to complete the session. All participants completed the intervention protocol within the 6-week timeline.

Berg Balance Scale Results

Balance scores for the BBS are provided in Figure 2. A significant effect of time was reported, $\Lambda_{Wilk's} = .057$, $F(4, 4) = 16.49$, $p = .009$, $\eta_p^2 = .94$. For the total score, there was a significant main effect of time, $F(2,14) = 9.89$, $p = .002$, $\eta_p^2 = .59$. Using a Sidak *post-hoc* test, total scores significantly decreased from baseline to pre-intervention ($p = .05$), and significantly increased from pre-intervention to post-intervention ($p = .02$). Total scores at baseline and post-intervention were similar ($p = .28$). For the static balance score, there was a significant main effect of time, $F(2,14) = 4.05$, $p = .041$, $\eta_p^2 = .37$, but no significant differences were reported between any of the three time points ($p > .05$ for all). For the dynamic balance score, with a Greenhouse-Geisser adjustment, there was a significant main effect of time, $F(1.21, 8.48) = 8.80$, $p = .014$, $\eta_p^2 = .56$. *Post-hoc* analysis indicated pre-intervention scores were significantly lower than baseline scores ($p = .001$). post-intervention scores were similar to pre-intervention ($p = .09$) and baseline ($p = .996$) scores.

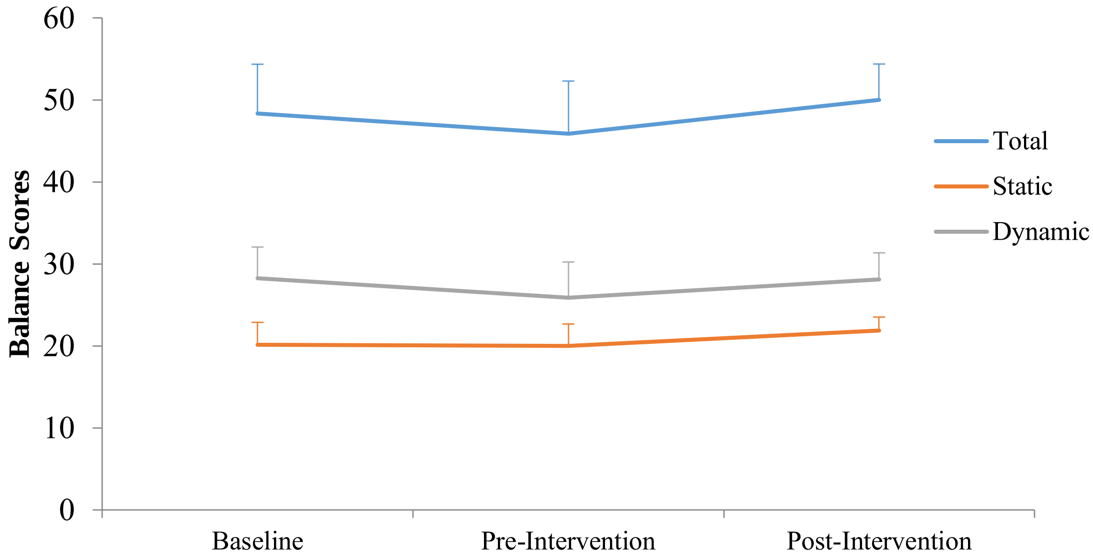

Figure 2. Berg Balance Scale: Total score = Summation of static and dynamic balance; Static = calculation of static balance test items; Dynamic = calculation of dynamic balance test items

Neurocom Balance Master, Limits of Stability

Reaction time (RT) and directional control (DCL), components of the LOS test, were used to assess postural sway, and dynamic balance at baseline, pre-intervention, and post-intervention. Data for RT and DCL in four different directions (i.e., front, right, back, left), with an overall composite score, are shown in Tables 4 and 5, respectively. Due to limited statistical power, only principle directions were reported. Each direction represented an average of swaying tasks that included a particular direction (e.g., front is an average of front-left, front, and front-right). No significant change over time for the combination of the two composite variables (i.e., RT, DC) was reported, $\Lambda_{Wilk's} = .841$, $F(4, 4) = .19$, $p = .93$, thus univariate follow-up tests were not justified.

Table 4

Reaction Time on Leaning Task Performance Scores for all Participants

	Baseline	Pre-Intervention	Post-Intervention
Front (s)	0.81 ± 0.26	0.92 ± 0.26	0.83 ± 0.30
Right (s)	0.99 ± 0.40	0.93 ± 0.37	0.94 ± 0.30
Back (s)	1.06 ± 0.84	0.81 ± 0.23	0.92 ± 0.27
Left (s)	0.93 ± 0.47	0.80 ± 0.27	0.95 ± 0.29
Composite (s)	0.94 ± .0.50	0.87 ± 0.23	0.91 ± 0.26

Note. Values are mean ± SD.

Table 5

Directional Control on Leaning Task Performance Scores for all Participants

	Baseline	Pre-Intervention	Post-Intervention
Front (%)	77.78 ± 4.64	70.56 ± 12.78	70.70 ± 11.89
Right (%)	69.93 ± 11.97	68.26 ± 15.89	72.33 ± 11.22
Back (%)	54.96 ± 26.32	56.81 ± 27.93	57.74 ± 22.08
Left (%)	73.56 ± 11.77	70.67 ± 10.88	69.33 ± 13.82
Composite (%)	69.06 ± 11.69	66.57 ± 13.05	67.53 ± 12.55

Note. Values are mean ± SD.

Parkinson's Disease Questionnaire-39 Results

Due to the limited sample size, a repeated measure (RM) multivariate analysis of variance (MANOVA) was not feasible for PDQ-39 data. Thus, 8 separate RM ANOVAs were conducted on each of the 8 dimensions for the quality of life scale. The RM

ANOVA on the cognitive impairment dimension displayed a significant main effect of time, $F(1,7) = 14.08$, (see Table 6). This finding should be interpreted with caution due to the potential inflation of Type I error with multiple RM ANOVAs. All other dimensions did not significantly change over time ($p > .05$ for all). Although not statistically significant, the largest trends observed were a decrease in scores for most other dimensions, except for communication and bodily discomfort.

Table 6

Scores from the Parkinson's Disease Questionairre-39 at baseline and Post-Intervention

Dimensions	Number of Questions Per Dimension	Baseline	Post-Intervention
Mobility (%)	10	27.2 ± 18.4	25.0 ± 17.7
Activities of Daily Life (%)	6	28.7 ± 24.8	25.0 ± 25.9
Emotions (%)	6	21.8 ± 20.2	16.7 ± 13.0
Stigma (%)	4	18.1 ± 31.8	9.7 ± 12.5
Social Support (%)	3	12.0 ± 21.7	8.3 ± 11.0
Cognitive Impairment (%)	4	37.5 ± 20.5	21.5 ± 14.4[†]
Communication (%)	3	21.3 ± 26.4	22.2 ± 17.7
Bodily Discomfort (%)	3	32.4 ± 27.5	37.0 ± 24.7

Note. Values are mean ± SD and represent a percentage out of 100. [†] Significantly less than baseline ($p = .007$).

Participants also provided additional, unsolicited statements regarding the effects of the intervention (see Table 7). These statements were typically discussed at the beginning of the second session of a given week. These statements were also not disclosed to the other participants.

Table 7

Anecdotal Statements Given by the Participants During the Intervention

Stated they were able to stand for longer periods of time	(n = 7)
Expressed decrease in back discomfort	(n = 7)
Enjoyed the social aspect of coming to a college campus	(n = 8)
Registered for a university physical activity program	(n = 6)
Enjoyed simulated horseback riding	(n = 7)
Expressed sadness that the study was ending	(n = 8)

CHAPTER V

DISCUSSION, LIMITATIONS, CONCLUSIONS,

AND RECOMMENDATIONS FOR FUTURE RESEARCH

The purpose of this investigation was to determine changes in balance (i.e., static, dynamic) and QoL following 6 weeks of SHBR in older adults diagnosed with PD. In this chapter, a discussion is provided comparing the results from this investigation to the existing literature on the effects of SHBR on balance (static and dynamic) and QoL in older adults with PD. Information in this chapter is presented in the following sections: (a) Discussion, (b) Limitations, (c) Conclusions, and (d) Recommendations for Future Research.

Discussion

Parkinson's disease is a progressive and chronic neurodegenerative disorder that may affect physical and emotional health (Goodwin et al., 2008). There is no confirmed cause for PD, but age is a known risk factor. The aging process typically involves changes within specific sensory systems (e.g., vision, touch, vestibular, proprioception) causing a disruption in the ability of a person to control balance (Tinetti, 1988). The inherent pathophysiology of PD may therefore negatively affect balance and QoL (Karaa et al., 2012).

By the year 2020, older adults (i.e., aged 65 or older) will represent a greater percentage of the total population than ever before due to increased life expectancy

(National Institute of Aging, 2011). Therefore, the prevalence of PD may also increase. For this reason, it is imperative that researchers consider the current implications for older adults with PD, and to possibly determine interventions to slow the natural progression of the disease by improving symptoms such as balance dysfunction. However, there is a paucity in the research to support such findings in those with PD. Therefore, the primary researcher may contribute to bridging the gap in literature related to balance, SHBR, and PD.

Balance and Horseback Riding: Static and Dynamic Scores

While horseback riding, the rider's body performs movement patterns that are similar to walking on a level surface (Garner & Rigby, 2015). Specific body segments, including the lower back and pelvis, exhibit these patterns. The musculature in this area of the body allows for proper balance (e.g., posture). Horseback riding in a therapeutic setting has been reported to improve scores on clinical measures of static and dynamic balance (e.g., TUG, BBS) in older adults without any known neurological disorders related to balance impairments (Araujo et al., 2011; Homnick et al., 2013) and in older adults who have had a stroke (Beinotti et al., 2010) after 8 to 16 weeks of riding. Further, in an unpublished pilot study, a non-significant increase in balance was reported after 4 weeks of EAA, performed 2 times per week for 60 min per session in healthy older adults (Goudy et al., 2017).

The movement of the horse during EAAT is similar to the movements simulated by the device used for SHBR in this investigation. The movements on the simulator were programmed using biomechanical motion capture data collected during actual horseback riding (Chariot Innovations, 2018). Therefore, the physical stimulus experienced by individuals during SHBR may be similar to that experienced during EAAT. Kim and Lee (2015) reported that 8 weeks of SHBR, performed 5 times per week for 20 min per session, improved dynamic balance in older adults based on the results using the Limits of Stability (LOS) test. Significant increases were also reported in static balance, as well as, dynamic balance on the Berg Balance Scale (BBS) and Timed-Up and Go (TUG) Test after 6 weeks of SHBR, performed 5 times per week for 15 min per session in healthy older adults (Kang, 2015).

It should also be noted that SHBR may be useful for improving balance in adults with a chronic disease or disability. Individuals who had a stroke participated in a SHBR program for 6 weeks, 5 times per week for 30 min per session. Significant improvements in balance (i.e., static, dynamic) were observed (Kim et al., 2014). In a similar population with a similar frequency and duration of SHBR training, Kim et al. (2013) reported significant improvements in scores with several validated measures of balance (i.e., Functional Reach Test [FRT], Romberg Test, TUG Test).

In the current investigation, a non-traditional approach was used by separating the BBS into two balance subtests (i.e., static, dynamic) [see Appendix H]. The intention was to determine if any differences in specific types of balance existed. No statistically significant change in static balance between any of the time points was reported with this method.

According to Hoehn and Yahr (1967), static balance is not greatly affected in the early stages of PD. All participants in this investigation were in the early stages of PD (i.e., up to 6 yrs since diagnosis). For this reason, the potential for a ceiling effect (independent variable no longer has an effect on the dependent variable) should be considered. All participants at baseline scored high on the static balance portion of the BBS, with a mean score of 20 out of 24 (missing approximately one test item). This left a small margin for change. Of note, the most frequently missed test item within the static balance assessment at baseline was the tandem stance. However, from baseline to post-intervention, all participants improved on this task, although the improvements were not statistically significant.

Another interesting finding was with dynamic balance scores. When dynamic balance was analyzed alone, a statistically significant decrease in dynamic balance was observed from baseline to pre-intervention. Also, a non-statistically significant increase in scores from pre-intervention to post-intervention was observed. However, the post-intervention scores were statistically similar to baseline scores. These results support that participant's dynamic balance can be maintained after 6 weeks of SHBR if preceded by 6 weeks of physical inactivity. The trends observed in balance scores in this investigation could be attributed to a small sample size, thereby limiting power.

Decreases in dynamic balance have been reported previously in which adults with PD followed a similar control protocol. In an investigation conducted by Cancela, Mollinedo-Cardalda, Ayan, and Machado de Oliveria (2017), individuals with PD participated in a physical exercise (i.e., Pilates) program with strength training (i.e., TheraBand) for 12 weeks, 2 times per week for 60 min. The control group received a similar treatment, but without strength training. The intervention group improved significantly in dynamic balance and increased strength in lower limbs. The control group significantly decreased in angular velocity and total time while turning during the TUG test, a measure of dynamic balance and gait performance.

In another investigation (Ashburn et al., 2007) it was reported that individuals with PD participated in a home-based exercise program that consisted of lower-body muscle strengthening (i.e., knee and hip extensors, hip abductors), range-of-motion (i.e., ankle, pelvic tilt, trunk and head), balance training (i.e., static, dynamic), and walking for 6 weeks, 5 times per week for 60 min per session. The control group received usual care that consisted of contact with a nurse, who specialized in PD, who offered advice with exercise training. After 6 months, the participants who exercised maintained performance on the FRT, a clinical test of dynamic balance. The control group had significantly reduced scores on the FRT. These results support that lack of physical activity may lead to reductions in dynamic balance for those with PD.

In this investigation, there may be several reasons for the non-significant outcomes when balance components were measured separately. According to American College of Sports Medicine, there is evidence that some individuals with PD have aerobic capacities comparable to those of healthy older adults (Protas, Stanley, & Jankovic, 2009). However, due to the variation in symptoms (e.g., freezing, hesitation of movement), the mode of exercise is of importance, specifically related to safety. Though there have been investigations conducted using a variety of modes of traditional exercise (e.g., treadmills, assisted cycling), to date, there are no known investigations that included the use of SHBR as an intervention to improve functional outcomes in adults with PD.

There are some differences between traditional exercise and SHBR that are evident. Traditional aerobic exercise typically requires the recruitment of more large muscle groups during the activity (e.g., walking, running, cycling). Traditional resistance exercise may include a variety of activities that are prescribed to meet specific needs of the individual, and can target individual muscle groups. In contrast, SHBR does not offer the same variety, or the ability to, target specific muscle groups in the same manner as traditional exercise. Those who undergo SHBR training are required to be in a seated and stationary position, prohibiting the activation of many muscle groups (e.g., upper torso, arm and leg muscles). As SHBR is a fixed modality, the option to tailor the exercise according to the needs of the participant is not a possibility. Non-weight bearing forms of traditional exercise may also require (and demand) proprioceptive input that affect balance. During the SHBR, the individual relies primarily on static balance while in a seated position. Therefore, dynamic balance responses may not have been directly challenged during the intervention.

During EAAT, there is often an activity protocol added to the riding session (e.g., holding arms out to the side, stretching, functional reach). By adding an upper-body exercise protocol to the current investigation, there may have been more favorable results with regard to balance due to an increase in energy expenditure, cardiovascular stress, and rating of perceived exertion through the recruitment of more large muscle groups.

Researchers should also be mindful of the exercise intensity, duration, and frequency for individuals with PD, and how this prescription can be applied so that patient goals may be met. For example, according to Protas et al. (2009), recommended aerobic exercise should be performed at moderate-intensity for optimal results (e.g., improvements in balance, gait, endurance, rigidity) in those with PD. However, in the current investigation, the intensity was fixed according to the speed of the BearBack (50 Hz) and not according to the relative physiological responses of the participants (e.g., heart rate, rate of perceived exertion [RPE]). Although heart rate reserve was used as an option to gage intensity, none of the participants reached the necessary target heart rate range needed to maintain a moderate intensity. Likewise, some participants never reached the necessary perceived exertion levels needed to maintain a moderate intensity.

The highest intensity that could be set without compromising the structural integrity of the simulator was 50 Hz. This intensity corresponded to a moderate walking pace of a quarter horse (Chariot Innovations, 2018). It was determined at the completion of the investigation that 4 of the 8 participants did not reach moderate-intensity levels, according to the modified RPE scale, with this fixed intensity of 50 Hz.

The recommended duration for moderate-intensity exercise in adults with PD is 30 to 60 min per session (Protas et al., 2009). This suggested duration is based on the minimum time needed to elicit the necessary physiological responses that may lead to improvements in functional outcomes and symptom management without contraindications. The duration of the intervention consisted of 2 weekly sessions of steady-state exercise for 50 min per session. However, the ACSM recommends at least 90 min (180 min maximum) of aerobic exercise per week (3 days per week), with additional resistance and flexibility training, in adults with PD (Riebe, 2018).

Another potential implication of the results of the current investigation includes the frequency of exercise. Although the investigation was conducted over a period of 6 weeks, 2 times a week, ACSM recommends aerobic activity be performed at least 3 days per week. Further, in previous investigations, 5 days per week of SHBR training elicited significant improvements in dynamic balance (Kim et al., 2014; Kim & Lee, 2015; Kang, 2015). Therefore, in the current investigation, differences could be attributed to inadequate aerobic exercise intensity levels, duration, and frequency that are recommended for this population.

In addition to guidelines of aerobic exercise and the inherent pathophysiology of the disease, symptoms can vary day-to-day, week-to-week, or month-to-month. These variations could positively or negatively affect balance, gait, or other factors, such as sleep disturbances, comorbidities, emotional difficulties, progression of the disease, and/or circadian rhythm. Prescribed medication (e.g., Levodopa, Sinemet, Trihexphenidly) is more difficult to control and may have affected responses to exercise and therefore functional outcomes, including balance. The side effects of medication (e.g., increase in tremors, nausea, cardiac arrhythmias, postural hypotension, dizziness) were discussed throughout the study and how they were unique to each participant. Most participants exhibited fewer of these symptoms in the morning (i.e., 6 of the 8).

Balance and Horseback Riding: Total Scores

A significant decrease from baseline to pre-intervention, and a significant increase from pre-intervention to post-intervention, was reported in total balance scores on the BBS. Scores from baseline to post-intervention were statistically similar. The combined scores from the BBS support that the lack of aerobic exercise may negatively impact balance (static, dynamic, or both) in individuals with PD. However, aerobic exercise (SHBR) may improve balance in individuals with PD, according to the scores on the BBS.

Total scores on the BBS have improved with various aerobic exercise protocols in adults with PD. According to Zettergren, Franca, Antunes, and Lavallee (2011), 8 weeks of exercise using a Nintendo Wii Fit program can increase total BBS scores from 31 to 42. McGough et al. (2016) reported that high cadence cycling on a tandem bike for 10 weeks can improve total scores from 52 to 54 on the BBS in 41 adults with PD. Performing five weeks of Ai Chi, an aquatic exercise program, improved scores on the BBS from 35 to 41 in 20 adults with PD (Kurt, Bykturnan, Bykturnan, Erdem, & Tuncay, 2018).

In previous investigations, total scores on the BBS minimally decreased after a period of physical inactivity in individuals with PD. According to Cakit, Saracoglu, Genc, Erdem and Inan (2007), 8 weeks of inactivity resulted in a decrease in balance scores from 42.6 to 41.4 on the BBS in 10 adults with PD. Hackney and Earhart (2008) reported similar results after 10 weeks of physical inactivity in 13 adults with PD, with a decrease of 0.5 total point on the BBS. In this investigation, total scores on the BBS decreased from 48.4 to 46.0 points from baseline to pre-intervention.

Therefore, in the current investigation, the statistically significant changes in total balance could be attributed to the positive outcome after participating in aerobic exercise with SHBR. It should also be considered that the lack of statistical significance on a specific balance type could be due to inadequate aerobic exercise intensity levels, duration, and frequency that are recommended for this population (Riebe, 2018).

Simulated Horseback Riding and Quality of Life

Currently, there is no known research related to SHBR and QoL; however, there is literature to support increases in independence (e.g., activities of daily living, increased endurance, balance improvements). Independence is a major component for potentially improving QoL in individuals with PD (Takahashi, Kamide, Suzuki, & Fukuda, 2016).

According Williams-Gray, Foltynie, Brayne, Robbins, and Barker, (2007), 57% of individuals with PD experience some cognitive impairment within the first 3 to 5 years after diagnosis. In the present investigation, it was determined that after 6 weeks of SHBR only the cognitive impairment dimension of QoL had a statistically significant improvement. However, observable improvements were evident with the remaining 7 dimensions, although not significant. The questions in the cognitive impairment dimension of the PDQ-39 were: (a) unexpectedly falling asleep during the day, (b) problems with concentration, (c) felt memory was bad, and (d) distressing dreams or hallucinations.

The first question was related to unexpectedly falling asleep during the day. This component can be attributed to poor sleep quality in individuals with PD (American Parkinson's Disease Association [APDA], 2018). However, it has been reported that aerobic exercise may increase levels of serotonin and norepinephrine in the brain, which may positively impact cognition and sleep in those with PD (Williams-Gray et al., 2007). Most participants (i.e., 7 of 8) in this investigation frequently mentioned their bouts with insomnia, and that the current medications provided little relief. It was discussed by 3 of the participants that they were able to sleep with minimal restlessness and for longer periods of uninterrupted sleep on days in which SHBR training took place. Their conclusion was that they were tired from the exercise, as well as, the physical demands getting to and from the intervention (e.g., parking, walk to the building, weather conditions).

The second and third questions involved issues related to concentration and memory. These non-motor symptoms occur in approximately 30% of people with PD, and can also include feeling distracted (concentration), forgetful (memory), or losing their train of thought in conversation (Michael J. Fox Foundation for Parkinson's Research, 2018). Further, according to Chaunhuri et al. (2006), individuals with PD indicate that memory loss affects QoL more than motor symptoms. Each participant in this study mentioned feelings of memory loss and how it was affecting their QoL (e.g., missing appointments, forgetting day of the week).

The fourth and final question related to distressing dreams or hallucinations may be caused from a combination of medication and a cognitive impairment (APDA, 2018). This particular test item was not addressed, as participants were not asked to stop taking medication at any time during this investigation.

Limitations

The first limitation, and most significant of this investigation, was the small sample size of participants, which limited the statistical power. Results are therefore not generalizable to the PD population as a whole. The day-to-day symptoms experienced (e.g., dyskinesia, hypokinesia) and the comorbidities among the participants (e.g., cardiovascular disease, genitourinary disease) were unique for each individual.

Second, the division of the BBS into static and dynamic balance subscales has not been validated or analyzed in previous investigations. Due to this, the use of these separate scales may not be a true, rigorous assessment of static and dynamic balance. Any changes observed within these subscales should be approached with caution.

Third, there is a potential risk for the Hawthorne effect (Landsberger, 1958). Participants in this investigation were aware they were being monitored during the intervention. The primary investigator was asked questions by the participants (e.g., "Am I sitting up straight?"). The primary investigator answered questions based only on what was observable during the intervention session. Therefore, the participants may have been responding to the presence of the primary investigator.

Fourth, limitations were associated with the use of the BearBack. The participant height restrictions for the BearBack were 155 cm to 185 cm. The simulator was placed on an additional platform to increase the height of the saddle. However, two participants were able to rest their feet on the floor, potentially affecting the results. The dial used for controlling speed was also sensitive and required multiple attempts throughout the investigation to reach the desired intensity. The controller was always within ± 0.5 Hz of the desired intensity value.

Fifth, prescribed medications (e.g., Levodopa, Sinemet, Trihexphenidly) may have affected exercise responses (e.g., heart rate, blood pressure) and possibly functional outcomes, including balance. The time of day for exercise is critical with this population and exercise should be planned around symptoms and potential side effects (e.g., increase in tremors, nausea, cardiac arrhythmias, postural hypotension, dizziness) from the medication.

Sixth, maximum cardiopulmonary responses during exercise were not measured. Therefore, exercise could not be prescribed based on a percentage of relative maximum exertion. The intensity on the BearBack was set to an absolute value and not based on relative participant values.

Conclusions

According to the BBS and within the limitations of this investigation, a 6-week SHBR training program had a significant effect on total balance in adults diagnosed with PD. Further, it was determined that the method used to analyze the BBS scores may produce different results. For example, when the scores for the BBS were analyzed in the traditional method of a total score, a decrease from baseline to pre-intervention, and an increase in balance from pre-intervention to post-intervention, was reported. Conversely, when scores from the BBS were separated, no significant change in static balance was observed. However, a statistically significant decrease in dynamic balance from baseline to pre-intervention was reported. These results support that balance can decline with lack of exercise. When measured again at post-intervention, participants' scores were statistically similar to the baseline scores, indicating that 6 weeks of SHBR training may be effective at maintaining balance when preceded by 6 weeks of physical inactivity. However, with scores returning to the approximate baseline levels, it is unclear if further SHBR has the potential to improve scores beyond baseline.

Cognitive impairment, a dimension of QoL, improved from baseline to post-intervention. This dimension is directly related to four questions on the PDQ-39 that address sleep, concentration, memory, and hallucinations. The results of this investigation may provide insight for practitioners who prescribe exercise for individuals with PD or other neurodegenerative diseases.

Recommendations for Future Research

There are numerous recommendations for future research related to horseback riding for older adults with PD. Future researchers should:

1. Consider the design of the investigation by adjusting the following: (a) a larger number of participants (e.g., with and without PD, gender differences, severity levels) to increase statistical power and to be able to generalize within the PD populations, (b) use a case-study design to determine specific changes within an individual as compared to a group, and (c) add a maintenance phase in the research design to determine if the intervention has a long-term effect, or if the intervention actually delays the natural progression of the disease.
2. Consider an investigation to validate the BearBack by replicating this investigation first with older, healthy adults and then with adults diagnosed with chronic disease.
3. Inquire about different assessment instruments for balance related to those with PD. Including more precise and sensitive assessment measures to determine minor balance changes. This should include both static and dynamic balance.

4. Consider an investigation that compares two interventions (e.g., walking, EAAT, SHBR) to determine which mode of exercise is the most promising for improvements on symptoms (e.g., cognition, gait, motor learning) in those with PD.
5. Consider including QoL measures (e.g., Nottingham Health Profile, Health-Related Quality of Life) to determine changes in individuals' perceived QoL after a SHBR program.

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APPENDIX A

Adapted Physical Activity Taxonomy and Strength of Recommendation Taxonomy Evaluations

Table 1

Non-motor Symptoms of Parkinson's Disease: Diagnosis and Management (Chaudhuri, Healy, & Schapira, 2006).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation C	Review of literature	Individuals with PD	To review non-motor aspects of Parkinson's disease and to discuss how poor recognition of non-motor symptoms delays appropriate treatment.	The researchers discuss the importance to early recognition of non-motor symptoms and the importance of care in patients with Parkinson's disease in order to provide better treatment. These factors (e.g. anxiety, mood, sleep patterns) are important because without proper identification and treatment the individual may experience implications related to QoL.

Note. PD = Parkinson's disease; SHBR = simulated horseback riding; QoL = quality of life.

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☐ Dynamic	☐ Static	☐ SHBR	☒ QoL	☐ Falls	☐ Exercise

Table 2

Equine Assisted Activities and Therapies: A Case Study of an Older Adult (Wehofer, Goodson, & Shurtleff, 2013).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Case study Pretest/posttest No statistical analysis was done due to no population norms *ABC* is a 16-item questionnaire measuring self-perceived confidence *Modified ACS* is a variety of 89 activities	76-year old female BMI 39 with comorbidities, ABC screening = 71%, with falls < 1 a year Setting: PATH premier accredited riding center located in Washington, Missouri	The purpose of this investigation was to explore the use of EAAT in improving static and dynamic balance, postural sway, fear of falling, and participation in older adults.	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 to be used with the OA population and may improve balance, postural support, and reduce FOF. It was concluded that 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 strategies with this population.

	BBS is a 14-item scale designed to measure balance The intervention used was a motorized barrel that the participant sat on for two 15 s trials each at two speeds .75 and 1.00 Hz	

Note. PD = Parkinson's disease; ABC = Activities-specified balance confidence scale; BBS = *Berg balance scale*; ACS = activity card sort; EAAT = equine-assisted activities and therapy; OA = older adults; FOF = fear of falling; SHBR = simulated horseback riding; QoL = quality of life

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☒ Dynamic	☒ Static	☒ SHBR	☒ QoL	☐ Falls	☐ Exercise

Table 3

Fall Risk Factors in Parkinson's Disease (Gray & Hildebrand, 2000).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Qualitative Prospective Study *UPDRS questionnaire* Fall Incident Diary Participants were requested to record the Fall Incident Diary, and mail it back at 1-, 4 to 8-week intervals. A 12-week face-to-face close up session. x^2 Correlations *t*-Test *p* = n/a	118 patients with Parkinson's Disease *Hoenh and Yahr rating scale* 0-4 Age: 40 to 80 years Gender: 73 male, 45 female Setting: Community	Identify the risk factors associated with falls for patients with Parkinson's disease, who are living in the community.	Fifty-nine percent reported one or more falls in the 3 month period. A total of 237 falls were reported, as follow: - Amount of falls: 18% reported one fall, 25% reported 2 to 3 falls, 10% reported 4 to 5 falls, and 7 % reported more than 5. - Type of falls: 40% whole body falls, 21% falls to the hands or knees, 36% near falls. - Gender: 66% of males, 49% of females In conclusion fall risk assessments should be standardized and objective to provide a more accurate tool for researchers to determine why falls occur and to potentially decrease the number of potential falls.

Note. UPDRS = *Unified Parkinson's Disease Rating Scale;* PD = Parkinson's disease; SHBR = simulated horseback riding; QoL = quality of life

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☐ Dynamic ☐ Static ☐ SHBR ☒ QoL ☒ Falls ☐ Exercise

Table 4

Visual Cues Combined with Treadmill Training to Improve Gait Performance in Parkinson's Disease: A Pilot Randomized Controlled Trial (Schlick et al., 2016).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Randomized control Non-blinded Mann-Whitney U test Wilcoxon signed ranks *P* = .05 *TUG* *UPDRS* *Freezing Gait Questionnaire* Treadmill Following visual cues	23 outpatients with PD from the Orthopedic department at Physical Medicine and Rehabilitation, with inclusion criteria: - *Hoehn and Yahr rating scale* 2 to 4 - Able to walk on a treadmill - Sufficient visual capacity - No neurological or orthopedic, or any walking impedance. - No cognitive impairment Setting: University hospital	To evaluate the effects of visual cues combined with treadmill training on gait performance in patients with PD.	Gait speed and stride length increased in both groups. Patients that received combined training had high remaining effects after maintenance. Further, this study suggest that visual cues combined with treadmill training have more beneficial effects on gait than treadmill training in patients with PD.

Note. PD = *Parkinson's disease*; TUG = *Timed Up and Go Test*; UPDRS = *Unified Parkinson's Disease Rating Scale;* PD = Parkinson's disease; SHBR = simulated horseback riding; QoL = quality of life.

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☒ Dynamic ☐ Static ☐ SHBR ☐ QoL ☐ Falls ☒ Exercise

Table 5

Effects of Exercise on Falls, Balance, and Gait Ability in Parkinson's Disease (Shan, Wong-Yu, & Mak, 2015).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation C	Review on exercise and falls Quantitative Meta-analysis	25 randomized control studies that include the following terms: - (Physical therapy OR physiotherapy OR rehabilitation OR training OR exercise OR movement) - AND Parkin* - AND (Balance OR postural stability OR Gait OR Fall).	To determine the effects of exercise training and enhancement of balance and gait ability and reduction in falls for people with PD and to investigate potential factors contributing to training effects on balance and gait ability of people with PD.	Exercise training can improve balance and gait abilities in individuals with PD and decrease their fall rates over both the short and long terms. Higher correlations were reported when training was conducted within facilities.

Note. PD = Parkinson's disease; SHBR = simulated horseback riding; QoL = quality of life.

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☒ Dynamic ☐ Static ☐ SHBR ☐ QoL ☐ Falls ☐ Exercise

Table 6

Prospective Assessment of Falls in Parkinson's Disease (Bloem, Grimbergen, Cramer, Willemsen, & Zwinderman, 2001).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Prospective Case-Control Unpaired *t*-Test x^2 Fisher's exact test Bonferroni-type correction *p* = .01 *Fall Questionnaire* Neurological Examination (*Hoenh &Yahr, UPDRS, MMSE*) Gait and Balance assessment (*Tinnetti Test Romberg*, *TUG*, Reaching, Stop walking when talking) 6 months of fall incident collection. The incident had to be recorded as follow:	59 moderately affected patients with idiopathic PD Mean age 61 years ambulant community residents 55 control participants (38 were patient partners, 17 healthy acquaintances of the patients or the investigators). Mean age 60 years (matched by age and sex) Setting: Community	Clarify the epidemiology, circumstances and the clinical impact of falls. To examine what clinical test could predict falls in daily life in patients with PD.	It was reported: 14.5% of controls and 50.8% of case group fell at least once. Recurrent falls were 25.4% in case group and only 2 events in control group. More cases were among people taking Benzodiazepines - 45.8% of case group had a fear of future falls affecting ADL (44.1%) 70% of falls were attributed to intrinsic factors in the case group, while 50% of falls were attributed to extrinsic factor in control group. Romberg test yield overall best diagnostic utility (sensitivity 65%, specificity 98%). Recurrent fallers were best predicted by disease severity (*Hoenh & Yahr Scale Stage III*). In conclusion, individuals with PD are nine times more likely to have recurrent falls, with most falls taking place indoors. Individuals with PD also have higher rates of adverse consequences of falls. Further, this study reported the ability to predict future falls based on

	- Circumstances and consequences of the fall - Describe the fall on their own words - Describe the environment setting (indoor/outdoor) - Specific activity at the time of the fall - Tick activity performed (Multitasking/Single tasking) - Effects of the antiparkinsonean medication (Insufficient effect/Good Effect/Good effect but excessive involuntary movement) - Classify the Fall: Intrinsic (personal disorder)/Extrinsic (environmental)		prior fall information and severity of PD.

Note. PD= Parkinson's disease; UPDRS= *Unified Parkinson's Disease Rating Scale*; MMSE= *Mini-Mental State Examination*; TUG= *Timed Up and Go Test;* ADL= Activities of Daily Living; SHBR = simulated horseback riding; QoL = quality of life

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☒ Dynamic ☐ Static ☐ SHBR ☐ QoL ☒ Falls ☐ Exercise

Table 7

Effect of Physical Exercise-Movement Strategies Programme on Mobility, Falls, and Quality of Life in Parkinson's Disease (Georgy, Barnsley, & Chellappa, 2011).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 2 Recommendation A	Quantitative Repeated-measures Prospective Longitudinal Design Fisher's Exact test x^2 Wilcoxon Signed Ranks test McNemar's Test *p* = .05 *UPDRS* *NFOG-Q* *PDQ-39 Questionnaires* *Tinnetti Test*	15 Participants.7 male, 8 female Mean Age: 77.1 years Mean disease duration: 8.4 years *Hoenh &Yahr:* - 6.7% stage I - 40% stage II - 46.6% stage III - 6.7% stage IV *UPDRS* mean: 19.1 Setting: National Health Service Community Hospital Rehabilitation program	Demonstrate the effects of a regular standardized tailored exercise program, using exercise and movement strategy training, on mobility, risk of falls, quality of life, and hospitalization in PD patients.	Tailored exercise intervention and movement strategies had a significant impact on gait freezing, number of falls, falls risk, and QOL in individuals with PD.

Note. PD= Parkinson's disease; UPDRS= *Unified Parkinson's Disease Rating Scale*; NFOG-Q= *New freezing of gait questionnaire*; *PDQ-39= Parkinson's disease questionnaire;* SHBR = simulated horseback riding; QoL = quality of life.

Dissertation key words marked as related to this publication:

☒ PD ☐ Balance ☐ Dynamic ☐ Static ☐ SHBR ☐ QoL ☒ Falls ☐ Exercise

Table 8

Exercise Programs Improve Mobility and Balance in people with Parkinson's Disease (Gobbi et al., 2009).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Pre Post Intervention Mixed Study 2 x 2 MANOVA Wilks' Lambda Wilcoxon *p* = .05 *Berg's FBS* *TUG Test* *Hoenh & Yahr* *UPDRS* *MMSE*	34 participants *Hoenh &Yahr*: 1 to 3 Group 1: - n = 21 - mean age: 67.9 - 11 females, 10 males - Multimode exercise Group 2: - n = 13 - mean age: 69.8 - 5 females, 8 males. - Adaptive program	To verify the effectiveness of two intervention programs on functional balance in people with idiopathic PD. Multi-mode exercise program: aerobic capacity, flexibility, upper and lower limb strength, motor coordination, and balance. Adaptive program: exercises related to flexibility, strength, motor coordination, and balance.	There were no significant differences between intervention programs. Both programs had a significant increase on *Berg FBS*, and *TUG* scores. Both groups improved their mobility and from pre- to post-test. Results: Mobility: $F_{1,32} = 4.775$; $p < .036$ Balance: $F_{1,32} = 69.884$; $p < .004$)

Note. PD = Parkinson's disease; MANOVA = Multivariate Analysis of Variance; FBS = *Functional Balance Scale*; TUG = *Timed Up and Go Test;* UPDRS = *Unified Parkinson's Disease Rating Scale*; MMSE = *Mini-Mental State Examination*; SHBR = simulated horseback riding; QoL = quality of life.

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☒ Dynamic	☐ Static	☐ SHBR	☒ QoL	☐ Falls	☒ Exercise

Table 9

Tai-Chi Improves Balance and Mobility in People with Parkinson's Disease (Hackney, & Earhart, 2008).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Pre-Posttest, Case-Control study Pilot study Randomization Individual change score were obtained. Absolute change score of the group were compared t-test unpaired Mann-Whitney Rank Sum Bonferroni correction p = .05, each test significance p=.004 *Berg Scale* *TUG* *Tandem Stance* *One leg stance*	33 participants with PD Tai-chi group (TC) n = 13 11 males, 2 females Mean age: 64.9 years Years with PD: 8.7 years *UPDRS*: 25.5 *H&Y*: 2.0 Control group (C) n = 13 10 male, 3 female Mean age: 62.6 years	Quantify the effects of Tai-chi in functional mobility, gait imbalance in people with mild to moderate PD, compared a matched untreated control group with PD. The Tai Chi group participated in 20 1-hour training sessions that were completed in 10 to 13 weeks Control group has 2 testing session between 10 and 13 weeks apart without interposing training.	After 10 and 13 weeks without training sessions had no differences within the C group were reported. After 20 1-hour training sessions the TC group had improvement in *Berg Balance Score, UPDRS, Tandem Stance, TUG*, and *6-min walk* compared to the C group. Improvements in kinematic gait parameters were observed in the TC group. Tai Chi participants reported satisfaction with the program, as well as, improvements in well-being, concluding that Tai Chi appears to be an appropriate, safe and effective form of exercise for individuals with mild-moderately severe PD. Results: *UPDRS*: $p < .025$ *Berg Balance Scale*: $p < .001$ *TUG*: $p < .093$ *Tandem stance*: $p < .018$ *One leg stance:* $p < .918$

	Gait *UPDRS* Satisfaction survey of the program	Years with PD: 5.5 years *UPDRS*: 24.0 *H&Y*: 2.0 Setting: Training facility.

Note. PD = Parkinson's disease; TUG = *Timed Up and Go Test*; UPDRS= *Unified Parkinson's Disease Rating Scale*; H&Y = *Hoenh & Yahr scale;* SHBR = simulated horseback riding; QoL = quality of life

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☒ Dynamic	☐ Static	☐ SHBR	☒ QoL	☐ Falls	☒ Exercise

Table 10

High Intensity Eccentric Resistance Training Decreases Bradykinesia and Improves Quality of Life in Persons with Parkinson's Disease: A Preliminary Study (Dibble, Hale, Marcus, Gerber, & LaStayo, 2009).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 1 Recommendation A	Quantitative Mixed Study Case-Control 2 x 2 ANOVA for each DV Bonferroni correction to control the increase of Type I error. p = .05 Muscle Force (MVIC) *Mobility Test (TUG, TMW)* *QOL (PDQ-39)*	19 Participants (9 control, 10 case group) Mild to moderate idiopathic PD Group matching for age, gender and disease severity H&Y: 1 to 3 Age: 40-85 years Setting: N/A	Compare the effects of chronic, high intensity, eccentric intervention with an evidence based exercise program on measures of clinical bradykinesia and QOL in persons with mild to moderate PD.	A 12-week program (3 days/week) of high intensity eccentric resistance training for 45 to 60 min sessions can produce an increase in muscle force production, reduce bradykinesia, and improve of QOL in people with mild to moderate PD. This study supports the inclusion of high intensity resistance training as a component of exercise interventions for participants with PD. In conclusion, the results of this study supports the inclusion of high intensity resistance training as a critical mode of exercise intervention for individuals with PD. Results: *TMW:* $p < .02$ *TUG:* $p < .03$ *PDQ-39:* $p < .08$

Note. ANOVA= Analysis of Variance; MVIC = Maximal Voluntary Isometric Force; TMW = *Ten Minutes Walking;* QOL = Quality of life; PDQ-39 = *Parkinson's Disease Questionnaire*; TUG = *Timed Up and Go Test*; H&Y = *Hoenh & Yahr Scale*; PD = Parkinson's disease; SHBR = simulated horseback riding.

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☐ Dynamic	☐ Static	☐ SHBR	☒ QoL	☒ Falls	☐ Exercise

Table 11

Impact of an Exercise Program on Physical, Emotional, and Social Aspects of Quality of Life of Individual with Parkinson's Disease (Rodriguez de Paula, Fuscaldi Teixeira-Salmela, Coehlo de Morais Faria, Rocha de Brito, & Cardoso, 2006).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Pre Post testing Paired t-test p = .05 *NHP* – comprised of 6 domains	20 Participants (14 male, 6 female) Idiopathic PD *H&Y*: 1-3 Mean age:61.5 years Mean Onset: 5.98 years Setting: N/A	To investigate QOL behaviors after a combined program of an aerobic conditioning and muscle strengthening and the various domains of quality of life in individuals with Parkinson's disease	Following a 12-week (3 days/week) exercise program, with 75 min session, significant improvements were reported for the total *NHP* score and for the emotional reaction, social interaction, and physical ability domains. In addition, there was a strong tendency for improvements in energy level, sleep, and pain. The highest gain was in social interaction at 41.38%. In conclusion, improvements of perception of QOL can produce positive health impacts Results *NHP*: Energy level $p < .057$ Pain level $p < .061$ Emotional reaction $p < .012$ Sleep $p < 0.057$ Social interaction $p < .001$ Physical ability $p < .006$

Note. PD = Parkinson's disease; NHP= *Nottingham Health Profile*; QOL= Quality of life; H&Y= *Hoenh & Yahr Scale;* SHBR = simulated horseback riding.

Dissertation key words marked as related to this publication:

☒ PD ☐ Balance ☐ Dynamic ☐ Static ☒ SHBR ☒ QoL ☐ Falls ☒ Exerci

Table 12

Effects of Exercise of Perceived Quality of Life of Individuals with Parkinson's Disease (Baatile, Langbein, Weaver, Maloney, & Jost, 2000).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Quasi-experimental Pre-Posttest Non-randomized clinical trial Wilcoxon Signed-Ranks test *p* = .05 *UPDRS* *PDQ-39*	6 male Mean age: 72.7 years 4 married 2 single All with cardiac history 3 subjects used canes regularly Mean onset: 3.8 years. *H&Y*: 1 to 3 Setting: Physical Performance Research Laboratory at Edward Hines Jr.	Observe whether individuals with PD, who participated in moderate intensity physical activity program (PoleStriding), experienced improvements in mental functioning, ADL, motor function, and overall QOL	Following an 8-week polestriding intervention, there were significant improvements on the subscales for mobility and ADL, according to the *PDQ-39*. Additionally, there were improvements in cognition and bodily discomfort scores. Significant differences were noted for the total *UPDRS* score following PoleStriding intervention. The increases include: perceived mentation, ADL, and motor skills. Results: *UPDRS* $p < .026$ *PDQ-39* $p < .028$

Note. UPDRS= *Unified Parkinson's Disease Rating Scale*; PDQ-39= *Parkinson's Disease Questionnaire*; H&Y= *Hoenh & Yahr Scale*; ADL= Activities of Daily Living; QOL= Quality of life; SHBR = simulated horseback riding

Dissertation key words marked as related to this publication:

☒ PD ☐ Balance ☐ Dynamic ☐ Static ☐ SHBR ☒ QoL ☐ Falls ☒ Exercise

Table 13

Changes in Cardiorespiratory Responses and Kinematics with Hippotherapy in Youth with and Without Cerebral Palsy (Rigby, Gloeckner, Sessums, Lanning, & Grandjean, 2017).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 1 Recommendation A	Quantitative Case-Control Pre Posttest mixed study Randomized 2x2 ANOVA 2x2x2 ANOVA *p = 0.05* Intervention: Treadmill Simulated horse saddle Pelvic Displacement Physiological Responses	12 children In Texas Control Group: n = 6 Age: 8 to 14 years Case Group: n = 6 Age: 5 to 18 years Classification: CP5 to CP8 Setting: Therapeutic Riding Center	The purpose of this study was to characterize pelvic displacement and cardiorespiratory responses to simulated horseback riding and walking (treadmill) in youth with cerebral palsy and to compare responses to youth without cerebral palsy before and after 8 weeks of hippotherapy and treadmill training.	Significant higher physiological responses were observed in the youth with cerebral palsy compared with the group without cerebral palsy while walking before and after the intervention. Eight weeks of hippotherapy did not alter responses, but anecdotal improvements in gait, balance, posture, and range of motion were observed in those with cerebral palsy. In conclusion, the results of this study enhance researchers understanding with regard to hippotherapy as an intervention to improve functional abilities in those with CP.

Note. ANOVA= Analysis of Variance; CP=Cerebral Palsy

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☒ Dynamic ☐ Static ☒ SHBR ☐ QoL ☐ Falls ☒ Exercise

Table 14

Improving Gross Motor Function and Postural Control with Hippotherapy in Children with Down Syndrome: Case Reports (Champagne & Dugas, 2010).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Pre-Posttest Case Study *Gross Motor Function Measure-88* *Power Spectral Analysis* 3 positions for 11 sessions for 30 min each -Facing forward -Side-sitting -Facing Backward *t*-test $p < .05$	2 Individuals with Down Syndrome Child One: Male Age: 28 months Child Two: Female Age: 37 Months Recruited through Regroupment pour la Trisomie 21	To describe the implications of 11 weeks of hippotherapy on gross motor function in children with Down Syndrome.	After 11 sessions of hippotherapy both children with Down Syndrome improved in many of the dimensions of the Gross Motor Function Measure-88, as well as, improved in acceleration signals according to the Poser Spectral Analysis. This investigation determined that after 11 weeks of hippotherapy gross motor skills and acceleration can improve.

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☐ Dynamic ☐ Static ☐ SHBR ☒ QoL ☐ Falls ☐ Exercise

Table 15

Effect of Hippotherapy on Postural Stability of Patients with Multiple Sclerosis: A Preliminary Study (Menezes, Copetti, Wiest, Trevissan, & Silveira, 2013).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Pre/Postest 16 weeks, two sessions per week for 50 min per session Force Plates to measure center of pressure for 30s with eyes open and closed *Berg Balance Scale* *ANOVA* *Post-hoc*: Tukey $p < .05$	11 participants with multiple sclerosis (MS) Mean of 8.57 years since diagnosis 32-58 years of age 8 female 3 male Intervention Group n = 7; 16 weeks of hippotherapy Control Group n = 4 No intervention	To identify the effects of hippotherapy on postural stability of individuals with MS	At the conclusion of this investigation it was determined that hippotherapy can be a possible intervention for balance disorders. There was a statistically significant improvement in balance after 16 weeks of hippotherapy. AmPap $p < .01$ VMml $p < .02$

Note. ANOVA = analysis of variance; MS = multiple sclerosis; AMPap = amplitude of medial lateral displacement; VMap = Velocity mean speed of the medial lateral displacement

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☐ Dynamic ☐ Static ☐ SHBR ☐ QoL ☐ Falls ☐ Exercise

Table 16

The Short-term Effect of Hippotherapy on Spasticity in Patients with Spinal Cord Injury (Lechner, Feldhaus, Gudmundsen, Hegemann, Michel, Zach, & Knecht, 2003).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Pre-Posttest (Before and after each session) 11 session of hippotherapy for 25 to 30 min per session *Ashworth Scale* *Wilcoxons signed-rank* $p < .001$	32 patients with spinal cord injury (SCI) 4 female 28 Male 16 to 72 years of age	To investigate the short-term effect of hippotherapy on spasticity of individuals with a SCI.	At the conclusion of this investigation it was determined that hippotherapy caused an immediate reduction in spasticity of the lower exterminates in individual with SCI. After 11 sessions of hippotherapy there was a substantial decrease in muscle tone in all 32 individuals with SCI. The means prior to intervention were 17.6 to 53.3 and after the intervention dropped to 16.6 to 42 according to the *Ashworth Scale*.

Note. SCI = spinal cord injury

Dissertation key words marked as related to this publication:

☐ PD ☐ Balance ☐ Dynamic ☐ Static ☐ SHBR ☐ QoL ☐ Falls ☒ Exercise

Table 17

Use of Hippotherapy in Gait Training for Hemiparetic Post-Stroke (Beinotti, Correia, Christofoletti, Borges, 2010).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Mixed Case-Control Pre Posttest Study Quarter horse-Gelding, 20 years old, 500 kg, 1.52 m in height, trained Fisher exact test Mann-Whitney test ANOVA *p =0.05* *FAC* *Fugl-Meyer Scale* *Berg Balance Scale* *Functional Assessment of Gait*	20 subjects diagnosed with stroke in the past 4 months. Group A (control): conventional treatment 3 times a week/16 weeks Group B: (experimental): conventional treatment twice a week and hippotherapy once a week /16 weeks Age: 30-85 years Setting: Center for Therapeutic Harmony and Physical Therapy and Occupational Therapy Clinic	To evaluate the hippotherapy training in post-stroke hemiparetic individuals. Further, to determine the influence of hippotherapy on gait after stroke, as well as, the influence level of motor impairment, balance, rhythm and dynamics of gait in stroke patients after treatment.	Significant improvement were observed in the experimental group including motor impairments in lower limbs, balance over time. Similar trend were observed in both groups. The gait independence, cadence, and speed were not significant. Hippotherapy combined with conventional physical therapy has a positive influence in gait training and brings the patients gait standard closer to normality than the control group.

Note. ANOVA= Analysis of Variance; FAC= *Functional Ambulation Category scale*

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☒ Dynamic ☐ Static ☐ SHBR ☒ QoL ☐ Falls ☒ Exercise

Table 18

The Effectiveness of Simulated Developmental Horse Riding Program in Children with Autism (Wuang, Wang, Huang, & Su, 2010).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Case-Control study Intervention: Simulated horse saddle x^2 unpaired t-test MANOVA *p = N/A* *BOTMP*-used to assess motor function with the focus of acquisition of patter and movement in children 4.5 to 14.5 years of age *TSIF*- consists of 98 items used to identify sensory integrative dysfunction in children 3 to 12 years	60 children with autism (13 girls, 47 boys) More males than females have autism Group A: 30 children, received SHBR in addition to regular OT Group B: 30 children received OT only Ages: 6 to 8 years Setting: N/A	(a) Design a simulated horse riding program JOBA (b) Examine the effectiveness of the simulated horseback-riding program in improving motor and sensory integrative function in children with autism.	After 20 weeks of 2 sessions per week for 40 min, Group A children with autism showed improved motor proficiency and sensory integrative functions after a combination of OT and simulated developmental horse riding program training. In addition, the treatment effect was maintained for at least 6 months. In conclusion, SHBR may be an effective intervention option for children with autism.

Note. MANOVA= Multivariate Analysis of Variance; BOTMP= *Bruininks-Oseretsky Test of Motor Proficiency*; TSIF= *Test of Sensory Integration Function*

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☒ Dynamic ☒ Static ☒ SHBR ☐ QoL ☐ Falls ☒ Exercise

Table 19

Effect of a Hippotherapy Intervention Program on Static Balance and Strength in Adolescents with Intellectual Disabilities (Giagazoglou, Arabatzi, Dipla, Liga, & Kellis, 2012).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Pre-Posttest Intervention: 10 weeks, 2 sessions per week for 30 min each session Balance measurement: Force plates pressure platform *Double-Leg Stance* (eyes open and closed) *One-Leg Stance* (eyes open) Both stances were to be held for 30s Strength measurement: Half-squats 3 maximal isometric half-squats	19 adolescents with mild intellectual disabilities (ID) Mean age 15.3 years Experimental group n = 10 Intervention 10 weeks of hippotherapy Control group n = 9 No intervention	To investigate the effects of a hippotherapy program on static balance and strength in adolescents with intellectual disabilities.	After 10 weeks of a hippotherapy riding program, there was no statistically significant interaction in the Double-Leg Stance with eyes open or closed. There was no statistically significant main effects of group for the left One-Leg Stance. However, for the One-Leg Stance there was a statistically significant group and time interaction on balance. In conclusion, this investigations results indicate an improvement in strength and balance tasks with individual with ID.

	repeated measures two way *ANOVA* *Post-hoc*: Tukey $p < .05$

Note. ANOVA = analysis of variance; ID = intellectual disabilities

Dissertation key words marked as related to this publication:

☐ PD	☒ Balance	☐ Dynamic	☒ Static	☐ SHBR	☒ QoL	☐ Falls	☒ Exercise

Table 20

Hippotherapy in Children with Developmental Delays: Physical Function and Psychological Benefits (Thompson, Ketcham, & Hall, 2014).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Pre-Posttest 12 session, one time per week for 45 min per session of hippotherapy Foothills Equestrian Center *Level and Unlevel 2x10 Walk* *Reach Test* *Gainesville Riding through Equine Assisted Therapy (G.R.E.A.T.) Postural Scale* *PedsQL-Standard Cognitive Functioning Scale* *PedsQL-Standard Pediatric Quality of Life Inventory*	8 children with developmental delays 6 male 2 female 2 to 12 years of age	To investigate the effect of 12 weeks of hippotherapy on posture, walking and reaching coordination, as well as, quality of life in children with developmental delays.	At the conclusion of this investigation it was determined that 12 weeks of hippotherapy 5 of 8 children improved by 62.5% in their *Postural Scale* score, 7 of 8 decreased their time to complete level and unlevel distances by 87.5%, and 4 of 8 improved by 50% in the *Reach Test* results. In addition, according to parent reports, it was determined that improvements in self-esteem and quality of life occurred after the hippotherapy sessions.

	PedsQL-Standard General Well-Being Scale *Wilcoxon signed rank test* $p < .05$

Dissertation key words marked as related to this publication:

☒ PD ☒ Balance ☐ Dynamic ☐ Static ☐ SHBR ☒ QoL ☐ Falls ☒ Exercise

Table 21

Effects of Hippotherapy on People with Cerebral Palsy From the Users' Perspective: A Qualitative Study (Debuse, Gibb, & Chandler, 2009).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation C	Qualitative Critical Realism paradigm Naturalistic Inquiry Approach Descriptive Coding Themes: Factors that influence the experience and the effect of hippotherapy (context and perception) The movement experience The physical effects The psychological effects	17 individuals with Cerebral Palsy Ages: 4 to 63 years Setting: 16 equine centers in Britain and Germany	The purpose of this investigation was to explore the reach of effects of hippotherapy on individuals with Cerebral Palsy.	Hippotherapy: - constitutes a unique opportunity for motor learning. - determined to be more effective than conventional physiotherapy by both user and parents. - psychological effects are critical to its overall effects (i.e., physical effects). - benefits people (regardless of age) with cerebral palsy. - Improved function following hippotherapy increased users' self-esteem and self-efficacy. - Both physical and psychological effects increase the quality of

	Users'/parents' responses to these effects Quality control -Audit trail -Triangulation -Participant Verification -Multiple coding		life of individuals with cerebral palsy.

Dissertation key words marked as related to this publication:

☒ PD	☒ Balance	☐ Dynamic	☐ Static	☐ SHBR	☒ QoL	☐ Falls	☒ Exercise

Table 22

Effect of Equine-Assisted Therapy on the Postural Balance of the Elderly (Araujo, Silva, Costa, Pereira, & Safons, 2011).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quantitative Quasi-experimental Pre-Posttest Non-randomized clinical trial Non-parametric statistics used Wilcoxon Signed-Ranks test Mann-Witney *p* = .05 *TUG* *Stabilometry*	17 older adults Age: 60 to 84 years Experimental Group n = 7 2 male, 5 female Intervention: biweekly Equine-assisted therapy for 30 min, for 8 weeks Control Group n = 10 10 female Intervention: none	To determine the effects of equine-assisted therapy on postural balance (i.e., static, dynamic) and fall risk among older adults.	Significant improvements in the *TUG Test* scores were observed in the experimental group (*p* =.04) while there was no change in the control group from pre-test to post-test after 16 equine-assisted therapy sessions. In conclusion, according to the *TUG Test* scores, equine-assisted activity may be a predictor of reduced fall risk in older adults.

Note. TUG = *Timed Up and Go Test*

Dissertation key words related to this publication:

☐ PD	☒ Balance	☒ Dynamic	☒ Static	☐ SHBR	☐ QoL	☒ Falls	☐ Exercise

Table 23

Effect of Therapeutic Horseback Riding on Balance in Community-Dwelling Older Adults with Balance Deficits (Homnick, Henning, Swain & Homnick, 2013).

Strength Level & Recommendation Level	**Research Method**	**Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Pre-test-posttest single-group trial Descriptive statistics Paired t-test p = .05 *Fullerton Advanced Balance scale (FABS)* *Rand Short Form 36 Quality of Life scale (Rand SF 36)*	9 older adults n = 9; 4 males, 5 female Mean age: 76.4 8-week observation period, followed by an 8-week equine-assisted program 1 hour per week, 8 weeks. Balance measurement at 0, 8, 16, and 24 using *FABS* Q(QoL) measurement at 8 and 16 weeks using the *Rand SF 36* Setting: Professional Association of Therapeutic Horsemanship (PATH) International Premier riding center	To determine the effects of an 8-week equine-assisted activity riding program on measures of balance and QoL in community-dwelling older adults with established balance deficits.	There was no significant difference in balance scores from the start to the end of the observation period. There was a significant improvement in the balance score from the start to the end of the intervention: 0 to 8 weeks (p =.35); 8 to 16 weeks (p = .001). There was no significant difference after the maintenance period 16 to 24 weeks (p =.908). In addition, perception of general health from start to the end of the study showed significant improvements (p = .003). In conclusion, equine-assisted activity is a safe activity for older adults with mild to moderate balance deficits and may lead to improved balance and perceived QoL.

Note. *FABS = Fullerton Advanced Balance scale; Rand SF 36 = Rand Short Form 36 Quality of Life scale;* QoL = quality of life

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☒ Dynamic ☒ Static ☐ SHBR ☒ QoL ☒ Falls ☒ Exercise

Table 24

The Effects of Horse Riding Simulation Exercise on Muscle Activation and Limits of Stability in the Elderly (Kim & Lee, 2015).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Quantitative Pre-test/posttest Independent t-test Paired t-test *p* = .05 Electromyography was used to measure muscle activation (i.e., rectus abdominis; erector spinae; quadratus lumborum; external oblique; gluteus medius) *Biorescue*: was used to measure Limits of Stability (LOS)	30 older adults 8 male, 22 female Age: over 65 years Experimental Group: n =15 5 male, 10 female Intervention: performed horse riding simulation 5 times a week, 20 min, for 8 weeks; and conventional therapy Control Group: n = 10 3 male, 12 female Intervention: conventional therapy	To investigate the effect of horse riding simulation on balance and trunk muscle activation and to provide evidence of the therapeutic benefits of exercise.	After the intervention, LOS significantly increased in all directions in the experimental group while there was no change observed in the control group. Further, muscle activation in all muscle groups (i.e., rectus abdominis, erector spinae, quadratus lumborum, external oblique, gluteus medius) measured increased significantly in the experimental group but no increase in activation was observed in the control group.

Note. LOS = limits of stability

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☐ Dynamic ☐ Static ☒ SHBR ☒ QoL ☐ Falls ☒ Exercise

Table 25

Effect of Horseback Riding Simulation Machine Training on Trunk Balance and Gait of Chronic Stroke Patients (Kim, Her, & Ko, 2014).

Strength Level & Recommendation Level	**Research Method**	**Sample Population**	**Purpose**	**Summary of Results**
Level 3 Recommendation A	Quasi-experimental Pre-Posttest Non-randomized clinical trial Kolmogorov-Smirnov Test Paired t-test p = .05 To assess static and dynamic balance: The *Trunk Impairment Scale* (*TIS*) *Bio-Rescue* To access gait: *Functional Gait Assessment* (*FGA*) and *GAITRite*,	20 chronic stroke patients 10 male, 10 female At completion of the study: 10 male, 7 female Mean age: 63.9 Years Intervention: performed SHBR for 6 weeks, 5 times a week for 30 min	To evaluate the effect of SHBR on trunk balance and gait of patients with Chronic stroke.	A significant improvement occurred in movement (i.e., sway area, distance, velocity) according to the *TIS*. Significant differences were also observed in gait velocity, cadence, stride length and double limb support. In conclusion, SHBR improved the trunk balance and gait of chronic stroke patients. Further, supporting the use of SHBR as a treatment modality for chronic stroke patients.

Note. *TIS* = The *Trunk Impairment Scale; FGA = Functional Gait Assessment;* SHBR= simulated horseback riding

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☒ Dynamic ☒ Static ☒ SHBR ☐ QoL ☐ Falls ☐ Exercise

Table 26

Effects of Mechanical Horseback Riding on the Balance Ability of the Elderly (Kang, 2015).

Strength Level & Recommendation Level	Research Method	Population	Purpose	Summary of Results
Level 3 Recommendation A	Pre-test/posttest Randomly assigned groups Paired t-test *p* = .05 To access balance: *Berg Balance Scale (BBS)* *Timed up and go Test (TUG)*	20 older adults Experimental Group: n = 10 7 male, 3 female Mean age: 70.1 years Intervention: simulated horseback riding; 6 weeks, 5 times a week for 15 min Control Group: n = 10 6 male, 4 female Mean age: 71.2 years Intervention: performed single-limb standing exercise for 6 weeks, 5 times a week for 15 min.	To evaluate the effect of mechanical horseback riding exercise on balance in older adults	Significant improvements were observed with a clinical measure of balance (i.e., *Berg Balance Scale*) and with a functional mobility assessment (i.e., *TUG Test*) in the experimental group. While the control group showed no significant improvement in either assessment after the 6 weeks. In conclusion, simulated horseback riding effectively improves balance in older adults and should be considered as a therapeutic method for physical therapy.

Note. *BBS = Berg Balance Scale; TUG = Timed Up and Go Test*

Dissertation key words marked as related to this publication:

☐ PD ☒ Balance ☐ Dynamic ☐ Static ☒ SHBR ☐ QoL ☐ Falls ☒ Exercise

APPENDIX B

Institutional Review Board Approval - Texas Woman's University

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378
email: IRB@twu.edu
http://www.twu.edu/irb.html

DATE: August 24, 2017

TO: Ms. Leah Goudy
Kinesiology

FROM: Institutional Review Board - Denton

Re: Notification of Approval for Modification for The Effects of Simulated Horseback Riding on Balance and Quality of Life in Older Adults with Parkinson's Disease (Protocol #: 19639)

The following modification(s) have been approved by the IRB:

One of the saddles (CoreTrainer) will be eliminated from the study because there is little research to support that tremors and exercise are related. As a result of this change, the title of the study is now changed: **From**: *"The Effects of Two Different Simulated Saddles on Balance, Resting Tremor, and Quality of Life in Older Adults with Parkinson's Disease"* **To**: *"The Effects of Simulated Horseback Riding on Balance and Quality of Life in Older Adults with Parkinson's Disease."*

Application, consent form, and scripts have been modified to reflect this change.

cc. Dr. Brandon Rhett Rigby, Kinesiology

APPENDIX C

Institutional Review Board Consent Form - Texas Woman's University

STAR Lab
304 Administration Dr.
Denton, TX 76204-5647

Leah Goudy
Pioneer Hall 119 E
lgoudy@twu.edu
940-898-2509

TEXAS WOMAN'S UNIVERSITY CONSENT
TO PARTICIPATE IN RESEARCH
for a Research Study entitled

"The Effects of Simulated Horseback Riding on Balance and Quality of Life in Older Adults with Parkinson's Disease"

PURPOSE

This research is being conducted for my dissertation and area of interest. Equine assisted activities have been well documented in recent studies regarding the many therapeutic benefits. These benefits include improved balance, according to Rigby and Grandjean, 2016:

> *"Balance can be improved if neuromuscular and vestibular mechanisms are affected. As the horse walks, its center of gravity is displaced three dimensionally with a rhythmic movement very similar to the human pelvis during walking."*

These activities may cause a response from you to increase your core strength, which in turn may increase your balance. The purpose of this study is to determine the effects of simulated horseback riding on static balance and your quality of life. Static balance and quality of life will be tested before and after the two phases (see Table 1). Intervention phases consist of a simulated saddle: the BearBack saddle. We hypothesize that static balance and quality of life will improve with the BearBack Saddle.

PARTICIPANT REQUIREMENTS and PRELIMINARY SCREENING

Participant Criteria

In order to be eligible to participate, you must have the following characteristics:

1. With Parkinson's disease.
2. Male or female ages 40 to 80 years of age.
3. Hoehn and Yahr classification stages 1 to 4 (i.e., able to walk or stand unassisted, ambulatory with or without assisted devices).
4. Ambulatory without assisted devices.
5. Should be free of any surgical procedures in the past 6 months.
6. Without orthopedic problems that could be exacerbated by exercise.
7. Without any known cardiovascular, pulmonary or metabolic disease.

Approved by the
Texas Woman's University
Institutional Review Board
Approved: August 14, 2017
Modifications Approved: August 24, 2017

Initials _______

STAR Lab
304 Administration Dr.
Denton, TX 76204-5647

Leah Goudy
Pioneer Hall 119 E
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TO PARTICIPATE IN RESEARCH
for a Research Study entitled

"The Effects of Simulated Horseback Riding on Balance and Quality of Life in Older Adults with Parkinson's Disease"

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These activities may cause a response from you to increase your core strength, which in turn may increase your balance. The purpose of this study is to determine the effects of simulated horseback riding on static balance and your quality of life. Static balance and quality of life will be tested before and after the two phases (see Table 1). Intervention phases consist of a simulated saddle: the BearBack saddle. We hypothesize that static balance and quality of life will improve with the BearBack Saddle.

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4. Ambulatory without assisted devices.
5. Should be free of any surgical procedures in the past 6 months.
6. Without orthopedic problems that could be exacerbated by exercise.
7. Without any known cardiovascular, pulmonary or metabolic disease.

Approved by the
Texas Woman's University
Institutional Review Board
Approved: August 14, 2017
Modifications Approved:
August 24, 2017

Initials _______

8. Comfortable with sitting on a simulated saddle 2 sessions per week, 60 minutes per session.Not taking medication that may affect exercise performance (e.g., beta-blockers).
9. That are novices to horseback riding (no riding in the last two years).
10. If physician alters medication, participant will be withdrawn from the study.

If you are currently taking medication and/or are participating in other modes of therapy, we request that you do not alter the schedules of your medication or therapy throughout the duration of the study.

EXPERIMENTAL METHODS and APPROACH

The preliminary visit and testing session will take place in Pioneer Hall, in the Biomechanics Laboratory, at Texas Woman's University, Denton, TX. Please do not hesitate to ask questions at any point during the study.

Preliminary Visit
An initial visit will take place at TWU, Pioneer Hall room 123, for all potential participants. At this time you will be asked questions about your diagnosis to determine if you are a match for this study. You will be provided with information about the study protocol and given the informed consent form to sign to allow for participation, as well as, a medical history form and a photo/video release form. You will then be provided a calendar and days for testing will be determined at this time as well as the testing order.

Familiarization Session
A familiarization session will take place at Pioneer hall, room 119 for all potential participants for 60 minutes. During this session, participant will be acquainted with the simulated saddle device by sitting on the saddle while not moving for a duration of 10 minutes. The simulated saddle will then be turned on by the primary investigator at the lowest speed for a duration of 10 minutes. Participants will verbally state either yes or no if they are comfortable while the saddle is stationary and in motion.

Testing Sessions
Testing will be conducted before and after each of the phases (see Table 1). Before each testing session, all procedures for the test will be reviewed and demonstrated if needed. At this time you will be asked again verbally of your willingness to participate. Before the first testing session, body mass and height will be measured.

Table 1 Study Timeline

Testing Session	Control Phase	*Testing Session*	Familiarization Phase	Intervention Phase	*Testing Session*
	6 weeks No intervention		1 weeks 1 sessions 60 minutes	6 weeks 2 sessions per week 60 minutes per session	

 Initials _______

Balance testing will be performed on the *Neurocom Balance Master*. This device has dual force plates connected to a computer that traces the horizontal movement of the center-of-pressure of the feet. For this test, you will independently perform eight tasks involving a directional leaning/balance protocol.

Balance will further be measured using the Berg Balance Scale (Berg, 1989). This balance test was developed to measure balance in older adults. The test consists of a 14 item scale that typically takes 15 to 20 minutes to complete with a point scale of 1 to 56. Some test items include: sitting to standing, standing with eyes closed, standing with feet together and turning 360 degrees.

Quality of life will be measured using the *PDQ-39 Questionnaire*. This self-report questionnaire measures the impact of daily living within relationships, social situations and communication in individuals with PD during the previous 30 days

Training Sessions
Each intervention phase will last six weeks. The simulated saddle exercise will be performed two times per week for up to 60 minutes each session with at least 48 hours between each training session.

Simulated Saddle Training:
You will complete one intervention phases. The intervention phase will include SHBR training, a mechanical device that can accurately reproduce the movements of a horse by activating muscles of postural stability. The saddle used in this study will be the *BearBack*. The intervention sessions will take place in Pioneer Hall, room 119, located at TWU in Denton, TX. During each SHBR session, you will be exercising at a moderate intensity. As a secondary measure, a wireless heart rate monitor will be placed around your chest.

Resting HR will be assessed in a seated position on a saddle after 5 minutes of sitting quietly. After resting data is collected, you will be asked to exercise on the saddle for 60 cumulative minutes. The exercise may be split into multiple 15-minutes bouts if needed. While on the saddle, you will be asked to maintain an erect posture, keeping the head, shoulders, and hips centered over the saddle, with feet placed in the stirrups.

In order for you to complete all requirements in this study, the total time commitment will be:

Preliminary visit:	**1.5 hours**
Familiarization session	**1 hour**
3 testing sessions at 30 min:	**1.5 hours**
12 training sessions at 65 min:	**13 hours**
TOTAL TIME COMMITMENT:	**17 hours**

Participant Benefits

For your participation, you will receive:

1. Your individual results from the testing.
2. Copy of completed manuscript of the study.

Initials _______

Potential Risks and Protection of Participants

RISK	STEPS TO MINIMIZE RISK
Falling while using simulated saddle	Every precaution will be taken by the researchers to prevent any injury or problem that could happen during the research study. Two researchers will always be standing next to you to ensure your safety from falling while exercising on the simulated saddles. If an injury should occur all proper and necessary medical and/or first aid procedures will be followed.
RISK	STEPS TO MINIMIZE RISK
Falling performing balance tests	Every precaution will be taken by the researchers to prevent any injury or problem that could happen during the research study. Two researcher will always be standing next to you to ensure your safety from falling while testing on the balance master. If an injury should occur all proper and necessary medical and/or first aid procedures will be followed.
RISK	STEPS TO MINIMIZE RISK
Pulls/strains of ligaments, tendons, muscles	According to the American College of Sports Medicine, there is little risk during submaximal exercise. However, risks include injury to muscles or joints. All of the possible risks associated with exercise testing will be minimized through preliminary screening and personal monitoring of each test by trained personnel.
RISK	STEPS TO MINIMIZE RISK
The risk associated with fatigue	While exercising on the simulated saddle, the testing sessions will be terminated before you reach a high or vigorous intensity. Participants will be withdrawn from the study if they request to stop, and will be informed that they may stop at any time.

Initials _______

RISK	STEPS TO MINIMIZE RISK
Loss of confidentiality	It is possible that there might be a loss of your confidentiality with data stored offline. To minimize this risk, all data forms collected will be coded using alphanumeric IDs. A single identification form linking names with your respective IDs will be kept in a separate folder from the other data. Researchers not associated with the study will have no access to the folders. There is also a potential risk of loss of confidentiality in all email, downloading, and internet transactions.
RISK	STEPS TO MINIMIZE RISK
Loss of anonymity	It is possible that multiple participants may be tested at one time, or that testing may take place such that you are exposed to the general public; because of this, you will be informed (before the study begins) that the loss of anonymity may be present. You may withdraw from the study at any time without penalty.
RISK	STEPS TO MINIMIZE RISK
Embarrassment	Words of encouragement and motivational language will be spoken by the researchers in the event you are embarrassed due to your performance during the testing sessions. The researcher will remind you that your participation is voluntary and that you may withdraw from the study at any time.
RISK	STEPS TO MINIMIZE RISK
Loss of time	Prior to the start of the study schedules will be made ahead of time for both the researchers and you. These schedules will include the day, time and location of the study.
RISK	STEPS TO MINIMIZE RISK
Coercion	Services provided to you will not be affected by participation/non-participation in the study. Participation is voluntary and you may withdraw from the study at any time.

RISK	STEPS TO MINIMIZE RISK
Sudden cardiac death	According to the American College of Sports Medicine, there is little risk during submaximal exercise. However, risks include a sudden cardiac event or even death. All investigators are CPR/AED certified. All of the possible risks associated with exercise testing will be minimized through preliminary screening and personal monitoring of each test by trained personnel. Individuals with congenital heart disease or known cardiovascular disease will be excluded.

At the beginning of each session, all of the procedures will be briefly reviewed with you. We will obtain your verbal consent to participate in the day's procedures.

Researchers will try to avoid any problem that may occur because of this research procedure. You should let the researchers know at once if there is a problem and they will help you. However, TWU does not provide medical services or financial assistance for injuries that might occur due to you taking part in this research.

YOUR RIGHTS TO PRIVACY

Your confidentiality will be protected to the extent that is allowed by law. All individual information obtained in this study will remain confidential and your right to privacy will be maintained. Data collected will be used for research purposes only and access will be limited to the investigators of this study. Only data reported as group means or responses will be presented in scientific meetings and published in scientific journals.

QUESTIONS ABOUT THIS RESEARCH

As investigators, it is our obligation to explain all of the procedures to you. We want to make sure that you understand what is required of you and what you can expect from us in order to complete this research project. Please do not hesitate to inquire about the research, your rights and responsibilities as a voluntary participant, or our roles as the investigators now or at any time throughout the study.

YOUR CONSENT TO PARTICIPATE

Your participation in this research is entirely voluntary. Your decision whether or not to participate will not jeopardize your future relations with Texas Woman's University and the Department of Kinesiology. You may withdraw your consent and discontinue participation at any time and for any reason without prejudice. Discontinuing your participation will involve no penalty of any kind.

Approved by the
Texas Woman's University
Institutional Review Board
Approved: August 14, 2017
Modifications Approved: August 24, 2017

Failure to comply with all of the procedures and to follow the instructions necessary for reliable and valid scientific measurements may result in termination of your participation in this study without your consent. You may be asked to withdraw if you fail to comply with all ofthe requirements for participation listed above. If you are withdrawn from participation by one of the investigators, our decision will not jeopardize your future relations with Texas Woman's University and the Department of Kinesiology.

CONTACT INFORMATION

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YOU WILL BE GIVEN A COPY OF THIS SIGNED AND DATED CONSENT FORM TO KEEP. IF YOU HAVE ANY QUESTIONS ABOUT THE RESEARCH STUDY YOU SHOULD ASK THE RESEARCHERS. IF YOU HAVE ANY QUESTIONS ABOUT YOUR RIGHTS AS A PARTICIPANT IN THIS RESEARCH OR THE WAY THIS STUDY HAS BEEN CONDUCTED, YOU MAY CONTACT THE TEXAS WOMAN'S UNVERSITY OFFICE OF RESEARCH AND SPONSORED PROGRAMS AT 940-898-3378 OR VIA EMAIL AT IRB@twu.edu

Participant's Signature **Date** **Email**

Printed Name

APPENDIX D

Neurocom Balance Master

APPENDIX E

Berg Balance Scale

Berg Balance Scale

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. *A recent study of the BBS, which was completed in Finland, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities.*

Description:
14-item scale designed to measure balance of the older adult in a clinical setting.

Equipment needed: Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Completion:

Time: 15-20 minutes

Scoring: A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56

Interpretation:
41-56 = low fall risk
21-40 = medium fall risk
0 –20 = high fall risk

A change of 8 points is required to reveal a genuine change in function between 2 assessments.

Berg Balance Scale

Name: ______________________________ Date: ________________

Location: ____________________________ Rater: ________________

ITEM DESCRIPTION	SCORE (0-4)
Sitting to standing	_______
Standing unsupported	_______
Sitting unsupported	_______
Standing to sitting	_______
Transfers	_______
Standing with eyes closed	_______
Standing with feet together	_______
Reaching forward with outstretched arm	_______
Retrieving object from floor	_______
Turning to look behind	_______
Turning 360 degrees	_______
Placing alternate foot on stool	_______
Standing with one foot in front	_______
Standing on one foot	_______

Total _______

GENERAL INSTRUCTIONS

Please document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met
- the subject's performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

Berg Balance Scale

SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hand for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or stabilize
( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding on.
( ) 4 able to stand safely for 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely for 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assist to sit

TRANSFERS
INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding on.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

Berg Balance Scale continued…

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING

INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)

( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm (5 inches)
( ) 2 can reach forward 5 cm (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION

INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.

( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING

INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)

( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

TURN 360 DEGREES

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)

( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

STANDING ON ONE LEG

INSTRUCTIONS: Stand on one leg as long as you can without holding on.

( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold ≥ 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.
( ) 0 unable to try of needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

APPENDIX F

Parkinson’s Disease Questionairre-39

PDQ-39 QUESTIONNAIRE

Please complete the following

Please tick one box for each question

Due to having Parkinson's disease, how often during the last month have you....		Never	Occasionally	Sometimes	Often	Always or cannot do at all
1	Had difficulty doing the leisure activities which you would like to do?	☐	☐	☐	☐	☐
2	Had difficulty looking after your home, e.g. DIY, housework, cooking?	☐	☐	☐	☐	☐
3	Had difficulty carrying bags of shopping?	☐	☐	☐	☐	☐
4	Had problems walking half a mile?	☐	☐	☐	☐	☐
5	Had problems walking 100 yards?	☐	☐	☐	☐	☐
6	Had problems getting around the house as easily as you would like?	☐	☐	☐	☐	☐
7	Had difficulty getting around in public?	☐	☐	☐	☐	☐
8	Needed someone else to accompany you when you went out?	☐	☐	☐	☐	☐
9	Felt frightened or worried about falling over in public?	☐	☐	☐	☐	☐
10	Been confined to the house more than you would like?	☐	☐	☐	☐	☐
11	Had difficulty washing yourself?	☐	☐	☐	☐	☐
12	Had difficulty dressing yourself?	☐	☐	☐	☐	☐
13	Had problems doing up your shoe laces?	☐	☐	☐	☐	☐

Please check that you have ticked ***one box for each question*** *before going on to the next page*

Due to having Parkinson's disease, how often <u>during the last month</u> have you....

Please tick <u>one</u> box for each question

		Never	Occasionally	Sometimes	Often	Always or cannot do at all
14	Had problems writing clearly?	☐	☐	☐	☐	☐
15	Had difficulty cutting up your food?	☐	☐	☐	☐	☐
16	Had difficulty holding a drink without spilling it?	☐	☐	☐	☐	☐
17	Felt depressed?	☐	☐	☐	☐	☐
18	Felt isolated and lonely?	☐	☐	☐	☐	☐
19	Felt weepy or tearful?	☐	☐	☐	☐	☐
20	Felt angry or bitter?	☐	☐	☐	☐	☐
21	Felt anxious?	☐	☐	☐	☐	☐
22	Felt worried about your future?	☐	☐	☐	☐	☐
23	Felt you had to conceal your Parkinson's from people?	☐	☐	☐	☐	☐
24	Avoided situations which involve eating or drinking in public?	☐	☐	☐	☐	☐
25	Felt embarrassed in public due to having Parkinson's disease?	☐	☐	☐	☐	☐
26	Felt worried by other people's reaction to you?	☐	☐	☐	☐	☐
27	Had problems with your close personal relationships?	☐	☐	☐	☐	☐
28	Lacked support in the ways you need from your spouse or partner?	☐	☐	☐	☐	☐
	If you do not have a spouse or partner tick here		☐			
29	Lacked support in the ways you need from your family or close friends?	☐	☐	☐	☐	☐

*Please check that you have ticked **one box for each question** before going on to the next page*

Due to having Parkinson's disease, how often <u>during the last month</u> have you....		Never	Occasionally	Sometimes	Often	Always
30	Unexpectedly fallen asleep during the day?	☐	☐	☐	☐	☐
31	Had problems with your concentration, e.g. when reading or watching TV?	☐	☐	☐	☐	☐
32	Felt your memory was bad?	☐	☐	☐	☐	☐
33	Had distressing dreams or hallucinations?	☐	☐	☐	☐	☐
34	Had difficulty with your speech?	☐	☐	☐	☐	☐
35	Felt unable to communicate with people properly?	☐	☐	☐	☐	☐
36	Felt ignored by people?	☐	☐	☐	☐	☐
37	Had painful muscle cramps or spasms?	☐	☐	☐	☐	☐
38	Had aches and pains in your joints or body?	☐	☐	☐	☐	☐
39	Felt unpleasantly hot or cold?	☐	☐	☐	☐	☐

Please tick <u>one</u> box for each question

Please check that you have ticked ***one box for each question*** *before going on to the next page*

Thank you for completing the PDQ 39 questionnaire

APPENDIX G

BearBack

APPENDIX H

Berg Balance Scale: Static and Dynamic Balance Separated

Berg Balance Scale			
Static Balance	**Points**	**Dynamic Balance**	**Points**
1. Standing unsupported	4	1. Sit to stand	4
2. Sitting unsupported	4	2. Standing to sitting	4
3. Standing eyes closed	4	3. Transfer	4
4. Standing feet together	4	4. Reaching forward to an object	4
5. Tandem Stance	4	5. Picking-up an object from floor	4
6. Standing on one foot	4	6. Turning to look	4
		7. 360 degree turn	4
		8. Step-up	4
Maximum Total	24	Maximum Total	32