The Impact of an Online Movement Training Program for Community-Based Adults and Older Adults on Balance, Physical Activity, Self-Efficacy and Resilience

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by

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DEDICATION

This is dedicated to my loving and supportive husband, Christopher, and my family.

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I would like to thank my mentor, Dr. Andrew Guccione, my committee, and my family for their ongoing support and encouragement over the last four years.

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ABC Scale ....Activities-Specific Balance Confidence Scale
CD-RISC …………………………………………...…Connor-Davidson Resilience Scale
DSHI……………………………….Center for Discovery Science and Health Informatics
HIPAA……………………………... Health Insurance Portability and Accountability Act
IPAQ …………………………………...….International Physical Activity Questionnaire
OPTIMAL........Outpatient Physical Therapy Improvement in Movement Assessment Log
PAR-Q……………………………………...Physical Activity Readiness Questionnaire
SLS……………………………………………………………………….Single leg stance
4SBT…………………………………………………………….... 4-Stage Balance Test

ABSTRACT

THE IMPACT OF AN ONLINE MOVEMENT TRAINING PROGRAM FOR COMMUNITY-BASED ADULTS AND OLDER ADULTS ON BALANCE, PHYSICAL ACTIVITY, SELF-EFFICACY AND RESILIENCE

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Objective: To examine the effects of a 30-minute, 3 times per week, 24-session at home online movement exercise program on balance, physical activity, self-efficacy, and resilience in community-based adults and older adults.

Background: Balance impairment is a commonly reported consequence of the aging process. It may lead to falls, serious injuries, and physical activity avoidance. Moreover, these sequelae may worsen when balance impairments work in concert with the psychological factors of decreased self-efficacy and resilience. Fortunately, existing evidence supports the use of movement training programs to improve balance in older adults. However, there are no known studies that examine the impact of a dual-task online movement training program on balance, physical activity, self-efficacy, and resilience and associations among these factors in community-based independent living older adults. Several critical relationships have been identified among balance, physical activity, self-efficacy, and resilience, which affect balance and physical activity after motor training that warrant further exploration.

Methods: Participants between the ages of 55-80 years of age were recruited from the Washington, D.C. metro area, including senior independent living facilities. Eligible participants were asked to complete a total of 24 30-minute training sessions, 2-3 times per week.

Outcome Measures: Participants completed pre- and post-test measures of static balance using the 4-stage balance test, physical activity using the International Physical Activity Questionnaire (IPAQ), self-efficacy using the confidence scale of the OPTIMAL instrument (OPTIMAL) and Activities-Specific Balance Confidence Scale (ABC), and resilience using the Connor-Davidson Resilience Scale (CD-RISC).

Data Analysis: Statistical analysis was completed using STATA/BE version 17.0 and Microsoft Excel. Comparison of means pre- and post-training was performed using a paired t-test with a significance level of $p \leq 0.05$ to determine if there was significant improvement in balance, physical activity, self-efficacy, and resilience. Wilcoxon signed-rank tests were used for comparisons of non-parametric data. Effect sizes were also calculated. Additionally, Pearson's correlations were used to determine the extent to which self-efficacy and resilience were associated with balance and physical activity before and after training.

Results: Significant differences between baseline and final measures were found for tandem stance, single leg stance (SLS), and CD-RISC. Moderate effect sizes were found for both tandem and single leg stance measures. Additionally, moderate correlations were found between baseline SLS and IPAQ measures, final ABC and SLS measures, final OPTIMAL and SLS measures, final CD-RISC and IPAQ measures, and final SLS and IPAQ measures. Strength of correlations increased between baseline and final measures for ABC and SLS, OPTIMAL and tandem stance, OPTIMAL and SLS, OPTIMAL and IPAQ, CD-RISC and tandem, CD-RISC and SLS, and CD-RISC and IPAQ.

Conclusion: Based on effect sizes, this study provides preliminary support for the efficacy of an at home online movement training program to make modest improvements in balance and physical activity, and small improvements in self-efficacy and resilience. Correlations among some aspects of balance, physical activity, self-efficacy, and resilience before and after training were also evident.

SPECIFIC AIMS

Among numerous factors influencing the health of older adults (aged 65 years and older), a fall is a major event that may result in various functional, social, and psychological consequences. Balance is an essential for functional mobility and activities of daily living. Although physical activity is a common recommendation to promote healthy aging, individuals with balance impairments may avoid participating in daily and physical activity altogether, leading to further deconditioning, diminished lower body strength, and even greater vulnerability to falls and subsequent injuries. Adding to the complex relationship between balance and physical activity, psychological factors may also impede or facilitate both balance training and participation in physical activity. Self-efficacy and resilience are two such psychological factors.

The existing evidence supports the use of movement training programs to improve balance in older adults. However, there are no known studies that examine the impact of an online dual-task movement training program on balance, physical activity, self-efficacy, and resilience and associations among these factors in community-based independent living older adults. Several critical relationships among balance, physical activity, self-efficacy, and resilience that potentially affect balance and physical activity after motor training warrant further exploration.

The overarching research question of the study is: What is the impact of a dual-task online movement training program on balance, physical activity, self-efficacy, and resilience in healthy, community-dwelling older adults and to what relationships can be found between and among the psychological factors, self-efficacy and resilience, and balance and PA? This broad research question will be answered using the following specific aims and hypotheses:

Aim 1: To determine the effect of an 8-week virtual dual-task training program on balance, self-efficacy, resilience, and physical activity in community-dwelling adults and older adults.

H1: Balance will improve as measured by the last two items of the 4-Stage Balance Test (length of time in tandem stance and single-leg stance (SLS)).

H2: Self-efficacy will increase as measured by the Activities-Specific Balance Confidence (ABC) Scale and the confidence section of the Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) instrument.

H3: Resilience will increase as measured by the Connor-Davidson Resilience Scale (CD-RISC).

H4: Physical activity will increase as measured by the International Physical Activity Questionnaire (IPAQ).

Aim 2: To determine the extent to which self-efficacy and resilience are associated with balance and physical activity before and after training in community-dwelling adults and older adults.

H1: Self-efficacy and resilience before training will be positively associated with balance and physical activity before training.

H2: Balance before training will be positively associated with physical activity before training.

H3: Self-efficacy and resilience after training will be positively associated with balance and physical activity after training.

H4: Balance after training will be positively associated with physical activity after training.

Investigation into an online dual-task movement training program to ameliorate balance impairment will provide clinicians with insight into more easily accessed movement training online, while addressing the interplay physical and psychological factors that contribute training outcomes. Findings may inform the design of online dual-task movement training programs for adults and older adults living in the community.

BACKGROUND/ SIGNIFICANCE

Throughout the normal aging process, musculoskeletal and sensory changes including joint stiffness, muscle atrophy, reduced ability to contract muscles, changes in gait, and vision disorders occur, leaving older adults at higher risk for balance impairment and subsequent falls.[1] Among numerous factors influencing the health of older adults (aged 65 years and older), a fall is a major event that may result in various functional, social, and psychological consequences. Falls are the leading source of fatal and nonfatal injury in older adults in the United States.[2,3] More than one out of every four older adults experience a fall each year, each time doubling the likelihood of falling again.[3,4] In 2018, falls among older adults resulted in 3 million emergency department visits, 950,000 hospitalizations and 32,000 deaths caused by fall-related injuries. In this scenario, balance and physical activity are key elements that support a healthy aging process.[5,6]

Balance is defined as "the ability to stay upright and steady when stationary and during movement".[7] Balance is essential to functional mobility and both basic and instrumental activities of daily living. Impaired ability to maintain balance may be related to a higher risk of falling.[8,9] Moreover, about one third of older adults who experience a fall, even if uninjured, develop a fear of falling.[10] This fear has been associated with even poorer balance performance[11] and often prompts a person to avoid participating in daily and physical activity altogether[10], leading to further deconditioning, diminished lower body strength, and even greater vulnerability to falls and subsequent injuries.[12] Physical activity, defined as "any bodily movement produced by skeletal muscles that results in energy expenditure",[13] is a common recommendation to promote healthy aging.[14] Thus, in order to minimize the functional decline associated with normal aging, exercise programs have often been promoted over the past several decades as essential to a healthy lifestyle contributing to both physical and psychological well-being.[15] Exercise is defined as "physical activity that is planned, structured, and repetitive and has as a final or intermediate objective in the improvement or maintenance of physical fitness".[13] Many exercise programs emphasize balance as fundamental to safe and efficient movement and function.

The literature suggests that balance impairment can be ameliorated through exercise programs in healthy community-dwelling adults and older adults.[7,16,17] For example, the widely prescribed Otago exercise program includes a progression of strength and balance exercises with increasing ankle weights and repetitions in conjunction with a walking plan.[18] A systematic review found that the program was effective in significantly reducing the rate of falls in community-dwelling older adults.[19] Interestingly, another systematic review on exercise for balance training for older adults concluded that exercises that challenge balance at a high dosage and do not include a walking program.[6] Finally, a third systematic review on balance training in older adults concluded that programs involving gait, balance, coordination, functional exercises, and strengthening exercises improve balance in certain indirect measures including the single leg stance. It was also noted that this evidence is not robust, as there are large amounts of missing data throughout the included studies.[7]

Despite the advancements in knowledge regarding the physical impacts of exercise on a person's engagement in physical activity, psychological factors impacted by exercise that may also impede or facilitate participation in physical activity have been less well studied in the physical rehabilitation literature. Self-efficacy and resilience are two such psychological factors that may contribute to the success of an exercise program to improve balance and promote physical activity.[20–23] Self-efficacy has been consistently correlated to physical activity, functional limitations, and quality of life in older adults.[24] Self-efficacy can be summarized as, "belief in one's capabilities to organize and execute the courses of action required to produce given attainments".[25] As explained by Bandura, an individual with low self-efficacy is less likely to exert optimal effort towards a task (e.g., exercise and physical activity) or persist in the face of difficulties,[26] especially if they are already struggling with obstacles to successful performance such as moving with a balance impairment. Several studies suggest balance interventions grounded in promotion of self-efficacy are more effective than those not grounded in promotion of self-efficacy.[27,28,29] Interestingly, self-efficacy has been reported as the most important variable in predicting physical activity behaviors,[20,30] and also a significant predictor of balance performance in the stroke population.[21]

Resilience has been proposed as another contributing factor to successful aging and quality of life.[31,32] Resilience describes a person's physical and psychological ability to recover and thrive in the face of adversity. In relation to the benefits of physical activity, physical fitness appears to have a buffer effect against the body's hormonal response to stress, contributing to reduced emotional and physiological reactivity as well as increased positive mood and well-being.[33] Physical fitness has been defined as, "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies"[34]. Furthermore, challenging physical activities have been shown to promote resilience by increasing confidence and mental toughness.[35] Resilience has been found to improve after a rehabilitation program in the stroke population,[36] thus indicating it can be a target modifiable factor in rehabilitation, yet has not been well studied outside of clinical populations.

Although the literature suggests that balance impairment can be ameliorated through motor learning programs in healthy community-dwelling adults and older adults,[7,16,17] best practices have not been fully identified.[17,37] Motor learning is defined as "the acquisition and/or modification of skilled action".[38] Over the last century, the dominant viewpoint among numerous motor learning theories was that motor learning is enhanced when practice conditions make information processing more challenging.[39] In 2016, Wulf and Lewthwaite proposed the OPTIMAL (Optimizing Performance through Intrinsic Motivation and Attention for Learning) theory of motor learning, which was the first motor learning theory to take into account the mounting evidence implicating the role of motivational and attentional influences on motor learning and performance.[39] Wulf and Lewthwaite's theory asserts that the three key motivational variables of *enhanced expectancies* of future performance, *learner autonomy*, and *external focus of* *attention* are crucial for optimal motor learning and performance.

Building on Bandura's self-efficacy theory,[25] Wulf and Lewthwaite assert that expectations of success or failure predict future performance. Performance expectancies may be determined by previous performance outcomes and can be enhanced through conditions that support positive feedback, lessen perceived task difficulty, increase conceptions of ability, and amplify positive affect.[39] Performance expectancies are also determined by perception of task difficulty and natural ability.[39] For example, an individual is more likely to succeed in a task if a task is presented as learnable.[28] On the other hand, if an individual has a previous negative experience with a task and views it as unlearnable, the individual is less likely to succeed.[27,28,39] Furthermore, providing learner autonomy by allowing individuals to exercise control over the environment enhances motivation, as it gives the learner some control of upcoming tasks.[39,40] Finally, conditions that enhance an external focus of attention on the intended movement effect is more conducive to motor learning compared to an internal (body) focus of attention.[39] For example, in golf, it is more important to focus on where you want the ball to go than your actual form of the golf club swinging.

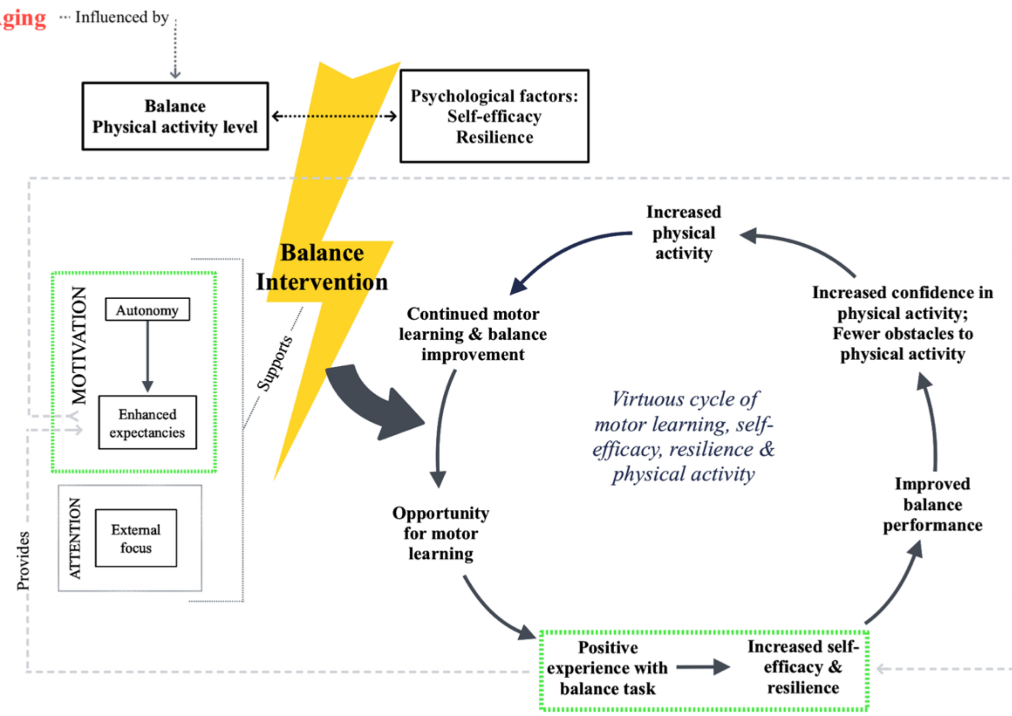

Figure 1 Theoretical Framework

Figure 1 (partially adapted from Wulf & Lewthwaite[39]) illustrates the theoretical framework for this study, applying elements of this theory of motor learning to frame the virtuous cycle and relationships among motor learning, physical activity, and psychological factors that may influence and in turn be influenced by a successful balance training intervention. To begin, participation in a balance training intervention that enhances expectancies and supports autonomy provides the opportunity for motor learning.[39] When an individual perceives a task as "doable" and has a positive experience with a balance task, the feeling of intrinsic reward increases self-efficacy and enhances expectations of success for future performance.[39] A positive experience and boost in self-efficacy contribute to motor learning and may function as major factors contributing to continued intervention participation among older adults.[37,41]

The association between self-efficacy and motor learning appear to have a neurophysiological basis.[39,42,43] The dopaminergic system has been identified as a major reward processor and one of its main targets is the striatum, a structure in the brain crucial to motor control.[43] When learning a motor task, it is believed that conditions that enhance expectancies and/or provide autonomy stimulate a dopaminergic response, preparing the brain for learning and temporally linking the dopaminergic response to performance attempts.[39,43]

There is some evidence supporting the significant roles of enhanced expectancies and learner autonomy in motor learning as outlined in Wulf and Lewthwaite's theory. In three different studies, providing positive feedback of performance (whether true or false) or artificially inflating an individual's conception of ability resulted in superior outcomes to the groups who did not receive conditions to enhance expectations.[27,28,44] Furthermore, it has been reported that giving learners choices about their environment, even ones incidental to the task, influence learning through satisfaction of a basic psychological need[39,45] and provide a sense of control over the upcoming tasks. Allowing learners to choose the duration or spacing of practice trials was found to result in more effective learning than the yoked control conditions.[46,47] Thus, structured motor learning programs that support learner's autonomy offer multiple challenges that can eventually be mastered and provide multiple opportunities for participants to experience personal success arising from their own efforts, further enhancing self-efficacy and resilience.

One approach to providing structured exercise programs in the home is through online programming. One such program is the Brain and Balance program available through The Braining Center, which incorporates a motor learning perspective through balance and cognitive exercises, with characteristics that may support self-efficacy and resilience. This intervention was designed to improve balance performance, cardiovascular endurance, and cognitive performance. The constructs of learner autonomy, enhanced expectancies, and external focus of attention as described by Wulf and Lewthwaite can be identified within this program. Learner autonomy is supported through participant's choice of when (day/time), frequency, duration, dosing, and location of video completion. Additionally, individuals are given the choice to sit or stand for many exercises, thereby enhancing motivation as it gives the learner some control of the task at hand and may *enhance expectancies*[39] for future tasks. The virtual avatars present the tasks as a learnable skill, thus supporting enhanced expectancies through vicarious experience and modeling by imitation of the virtual avatar. The videos may also enhance expectancies through verbal persuasion with the inclusion of phrases of positive encouragement such as, " 'Great job!', 'You did it!,' 'Nice effort!, and 'You're a champ!'." However, this positive reinforcement occurs regardless of performance, so a participant's notion of success may be discrepant with "correct" performance.

Several critical relationships emerge among balance, physical activity, self-efficacy, and resilience, which affect balance and physical activity after motor training that warrant further exploration. As stated above, existing evidence supports the use of movement training programs to improve balance in older adults.[5–7,16,17] Participation in physical activity provides more opportunity to improve balance through motor learning,[48] resulting in increased self-efficacy if successful.[48] Additionally, individuals with high self-efficacy are more likely to participate in physical activity[22,29,49,50] and have better balance.[10,11,21,28,48] Furthermore, individuals with better balance are more likely to engage in physical activity.[51] Ultimately, balance impairment may contribute to decreased SE and resilience, loss of independence, and poor quality of life.[52–54] Also, challenging physical activity has been shown to increase resilience.[35] However, there are no known studies that examine the impact of an online movement training program on balance, physical activity, self-efficacy, and resilience and associations among these factors in community-based adults and older adults. Given the high incidence of falls and their severe repercussions, investigation into an easily accessible, online motor learning intervention to improve balance and increase physical activity, self-efficacy, and resilience in older adults is critical.

Thus, the aim of the study is to investigate the impact of an easily accessible, online dual-task motor training program on balance, physical activity, self-efficacy, and resilience and the associations among these variables before and after training in healthy community-dwelling adults and older adults.

METHODS

Study Design

This single-arm prospective pre-experimental study consisted of 24 virtual training sessions over an 8 to 12-week period with pre- and post-training assessments. We proposed to test the hypothesis that *Brain and Balance*, a proprietary online program marketed under POWER BRAINing™ (The Braining Center, 2020), will improve balance, increase physical activity, self-efficacy, and resilience.

Target Population and Sample

The target population for this study included men and women, in generally good health, between the ages of 55 to 80 residing in the greater Washington DC metro area. The target sample was a convenience sample of individuals who may or may not reside in an independent living facility.

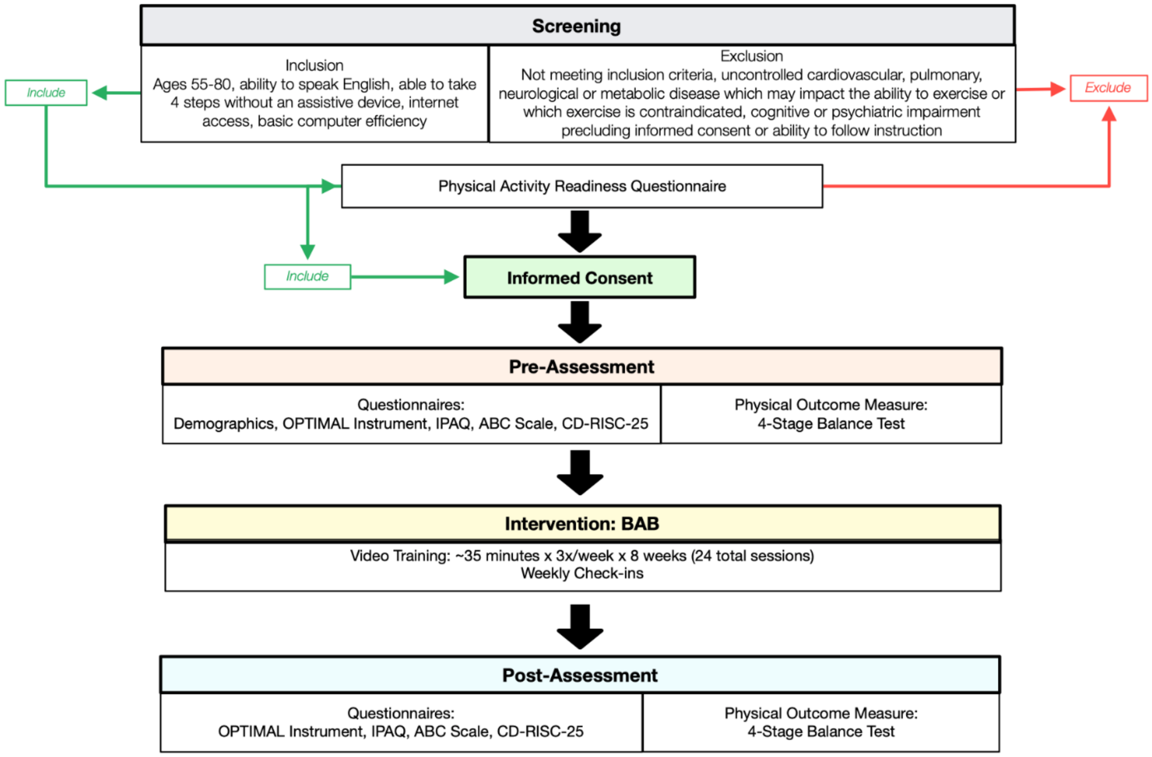

Figure 2 Schematic of Data Collection

Recruitment

Participants were recruited from the local community and from a local independent senior living facility through The Braining Center. Methods for recruitment included advertisements through emails, flyers, social media, and word of mouth. Approval of all marketing materials was obtained from appropriate personnel at the independent living facility prior to its distribution.

Participant Selection

Prospective participants initiated contact with the research team by emailing the designated study email address. A graduate research assistant responded to the inquiry by answering any questions and, if interested, scheduled a Zoom call to determine if the individual met basic eligibility. During the call, the screening tool was administered by the research assistant and recorded in the REDCap platform. This questionnaire is study-specific, developed to assess the eligibility criteria of inquiring individuals and provide standardized information regarding the purpose of this study. If the individual passed the screening tool, they then received a secure link via Zoom to complete an electronic version of the Physical Activity Readiness Questionnaire (PAR-Q),[55] which was used to assess an individual's physical fitness level and ability to engage in physical activity. If the individual answered "yes" to one or more questions on the PAR-Q they were deemed ineligible to participate due to risk factors.

Inclusion and Exclusion Criteria

Inclusion: Individuals between 55-80 years who have the ability to take at least 4 steps without an assistive device and the ability to speak English and exhibit competence in basic computer skills. *Exclusion:* Uncontrolled cardiovascular, pulmonary, neurological, or metabolic disease (excluding obesity), which may impact the ability to exercise or in which exercise is contraindicated; or cognitive or psychiatric impairment precluding informed consent or ability to follow instructions.

Consent Procedures

If a participant met all the inclusion and exclusion criteria, passed the PAR-Q, and elected to participate, the research assistant sent a secure link via Zoom containing the informed consent file that was e-signed. The informed consent was administered in accordance with procedures outlined by the George Mason University Institutional Review Board. The researcher read aloud and explained the study rationale, procedures, risks, benefits, and voluntary participation. The participant was given the opportunity to ask questions he or she may have. If the participant expressed understanding and agreed, he or she was asked to electronically sign his/her name on the informed consent through the REDCap platform where it was securely stored. Next, the enrolled participant electronically completed a demographics survey in REDCap. Finally, the research assistant scheduled a second Zoom call for the virtual baseline assessment.

Assessment Instruments

In addition to a demographics survey, the following assessments were administered during the scheduled videoconferences using the Zoom and REDCap virtual platforms. Unique survey links were securely sent to each participant through the Zoom chat box during the Zoom videoconference. Data was securely stored within the REDCap platform and only accessible by members of the research team. In addition to providing the written instructions included on questionnaires, the research assistants provided specific verbal instructions and were present during each assessment to answer any questions. Baseline assessments were completed within two weeks of consenting and final assessments were completed within two weeks after finishing the intervention. Self-efficacy was measured by e-versions of the confidence scale in the Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) and the Activities-Specific Balance Confidence (ABC) Scale; physical activity was measured using an e-version of the International Physical Activity Questionnaire (IPAQ); resilience was measured using an e-version of the Connor-Davidson Resilience Scale; (CD-RISC) balance was measured by the 4-Stage Balance Test (4SBT) via Zoom videoconference.

Outpatient Physical Therapy Improvement in Movement Assessment Log

The OPTIMAL instrument[56] is a self-report assessment that measures difficulty and confidence in performing 22 movements that are necessary for an individual to accomplish various functional activities. For purposes of this study, only the questions from the confidence section (used to measure self-efficacy) of assessment were asked since we are not interested in the "difficulty". The confidence scale of the OPTIMAL has been found to have high construct validity for the trunk (0.87), lower extremity (0.95), and upper extremity (0.95).[56] Minimal to moderate ceiling effects have been reported on some of the items on the OPTIMAL. Because an electronic version of the survey did not yet exist in REDCap, the research team developed the online survey by closely following guidelines outlined by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) task force for equivalence between electronic and paper-based patient-reported outcomes (PRO).[57]

International Physical Activity Questionnaire Long

The International Physical Activity Questionnaire Long (IPAQ)[58] is a 27-item self-report assessment of physical activity, and can be used as continuous or categorical data. The IPAQ can be used in a clinical setting or to compare physical activity levels across populations internationally. Duration and frequency of physical activity is measured in the domains of 1) job-related, 2) transportation, 3) housework, house maintenance, caring for family, 4) recreation, sport, and leisure-time, and 5) time spent sitting. Additionally, subscores can be calculated for 1) walking, 2) moderate-intensity activity, 3) vigorous-intensity activity, and 4) each domain.[58] For purposes of this study, total physical activity was calculated as a continuous variable using responses to all questions. The IPAQ has excellent test-retest reliability for overall score (ICC= 0.81),[58] and adequate concurrent validity for total time spent in physical activity, in combined vigorous and moderate physical activity compared to accelerometer monitoring ($\rho = 0.55$, $\rho = 0.36$).[59]

Activities-Specific Balance Confidence Scale

The Activities-Specific Balance Confidence (ABC) Scale[60] is a 16-item self-report measuring participant's balance confidence in performing different activities without losing balance. Each question begins with, "How confident are you that you will not lose your balance or become unsteady when you…", to which participants respond by selecting a score from 0% (no confidence) to 100% (completely confident). The ABC Scale has excellent test-retest reliability in the older adult population ($r = 0.92$, $p < 0.001$)[60] and excellent internal consistency in community-dwelling older adults (Cronbach's alpha = 0.96).[61] Additionally, the ABC Scale has been used as a valid measure of balance self-efficacy in several studies.[21,29,53,62]

Connor-Davidson Resilience Scale

The Connor-Davidson Resilience Scale[63] (CD-RISC) is a self-reported scale consisting of 25 items measuring resilience with a theoretical foundation in stress, coping and adaptation research.[64] Participants responded to each statement using a 5-point Likert scale, ranging from 0 (not true at all) to 4 (true nearly all the time). The CD-RISC has excellent internal consistency within the general population (Cronbach's alpha = 0.89) and excellent test-retest reliability ($r= 0.87$).[63]

4-Stage Balance Test

The purpose of the 4-Stage Balance Test[65] (4SBT) is to assess static balance by holding four progressively more challenging positions. This test originally evolved from the FICSIT study, which showed moderate to high correlations between balance and physical function.[66] Today, the 4SBT is used through the STEADI initiative by the CDC to determine fall risk. Fall risk is determined by whether or not an individual can hold tandem stance for 10 seconds, and single leg stance (SLS) for 10 seconds.[65] For purposes of this study, participants were asked to hold the tandem and SLS for as long as they can, or up to 10 seconds and 30 seconds, respectively. Participants were allowed to rest their hands on a countertop, chair back, or wall while they positioned their feet as instructed by the research assistant, but timing begins once they are hands free. The four testing positions were: feet side-by-side, one foot placed with the instep touching the big toe of the other foot, tandem stance, and single limb stance. The goal was to maintain each of the first 3 positions for 10 seconds and the final position (SLS) for 30 seconds without using their hands for support or moving their feet. The 30 second limit was adapted from use of the Mini-BESTest (a balance measure) to avoid ceiling effects.[67] Before beginning the 4SBT, the participant was asked to adjust their computer camera and position themself so that the research assistant can see a full view of them when standing. For purposes of this study, the focus was on tandem and SLS. It is important to note that the ability to hold tandem stance for 10 seconds is considered a cut score for fall risk.[68]

Although unrelated to the aims of this study, additional assessments were used to measure changes in attention and auditory working memory, visual spatial working memory, information processing speed, and leg strength.

Intervention

Content

A commercially available online dual task movement training program known as "Brain and Balance" (The Braining Center www.brainingcenter.com) served as the training program. This intervention was designed to improve balance performance, cognitive performance, and cardiovascular endurance. The intervention consisted of 24 online training classes with three sessions a week for 8-12 weeks (dependent upon participant's pace). For each 30-minute class, participants followed the instructions and demonstrations provided by the virtual avatar to carry out the various exercises and tasks. Videos were presented in a progressively challenging manner for all domains. To promote cardiovascular conditioning the exercises were structured to keep the participant in motion while maintaining an elevated heart rate using techniques such as squats, marching and upper extremity movements. To promote cognitive performance, participants were asked to complete simple and complex cognitive tasks, such as arithmetic, spatial memory recall and attention while completing the physical exercises.

Table 1 Durations of exercises in video intervention

Breakdown of Exercises in Video Intervention	***Total Length of Training over 24 Sessions***	***Average Length of Training per Class***
Warm Up	71:18:00	2:58:15
Heart Rate Variability Training	70:35:00	2:56:28
Balance Exercises	**27:56:00**	**1:09:50**
Cardio Cog	84:36:00	3:31:30
Dextercises	22:23:00	0:55:58
Visual Tracking	43:40:00	1:49:10
Balance & Squat Exercises	**86:58:00**	**3:37:25**
Rapid Reaction	83:24:00	3:28:30
Metronomic Timing Exercises w/ Cog Challenge - Hands based exercise	36:21:00	1:30:53
Metronomic Timing Exercises w/ Cog challenge- Lower body-based exercise	41:07:00	1:42:48
March Reminder (Cardio exercise w/ breathing training)	15:25:00	0:38:33
Power Ups	44:10:00	1:50:25
Seated Stretch	26:40:00	1:06:40
Mindfulness	83:51:00	3:29:38
Total Primary Balance Exercises + Primary Balance & Squat Exercises:	**114:54:00**	**4:47:15**
Total Secondary Balance Exercises:	**256:06:00**	**10:40:16**
Total All Balance Exercises:	**371:00:00**	**15:27:31**
Total (all exercises):	**738:24:00**	**30:46:00**

To promote balance performance, videos progressively challenged participants to perform movement tasks integrating narrower base of support exercises such as single leg stance or multi-planar movements versus single plane. For example, primary balance exercises included:

Table 2 Examples of Primary Balance Exercises

Video #	*Primary Balance Exercise Description*
1	The avatar instructed the participant to: 1) stand on left leg, 2) make a star shape with the right leg by moving it forward, forward and right, to the right, backward and right, backward, and backward and left, 3) switch to other leg & repeat
12	The avatar instructed the participant to: 1) raise right leg, 2) clap above head, 3) clap below their lifted leg, *(Repeat steps 1-3 multiple times)* 4) switch to the other leg & repeat
24	The avatar instructed the participant to: 1) lift their right foot in front of them as high as possible and hold for 5 seconds, 2) lift their right foot behind them as high as possible and hold for 5 seconds, *(Repeat each movement a few times)* 3) switch to the other leg & repeat

Examples of primary balance and squat exercises included:

Table 3 Examples of Primary Balance and Squat Exercises

Video #	*Primary Balance & Squat Exercise Description*
1	The avatar instructed participant to: 1) keep mouth closed with tongue on roof of mouth, 2) cross left arm under right arm, 3) perform a series of squats while focusing on breathing
12	The avatar instructed participant to: 1) place feet shoulder-width apart and facing same direction, 2) squat as far down as comfortably can, 3) balance on one foot 4) squat again 5) balance on other foot (*Repeat steps 1-5 multiple times)*

24	The avatar instructed participant to: 1) place feet shoulder-width apart and facing same direction, 2) squat as far down as far as comfortably can 3) balance on one foot 4) squat again 5) balance on other foot (*Repeat steps 1-5 multiple times)*

Subsequent balance exercises included the warm-up (marching), cardio cog (jogging/marching in place), visual tracking (while standing), and metronomic timing exercises w/ cog challenge- lower body-based exercise (tap steps to metronome). Additionally, mindfulness, or mind-clearing, segments were included in the program, as mindfulness has been associated with enhanced balance performance as a result of increased automaticity in movement control.[69]

Safety was emphasized in each balance exercise by offering the participant a choice to do the exercise in a seated position, standing position, or alternative position standing behind a chair and holding onto it. Also, the balance and squat exercises emphasized safety by offering the participant to choose from either the seated position, the standing position, or an alternative of using a chair to squat down on. In addition to providing safety measures, these choices also provide *learner autonomy*[39] by allowing individuals to exercise control over the environment, thereby enhancing motivation as it gives the learner some control of the task at hand and may *enhance expectancies*[39] for future tasks. The videos may also enhance expectancies through the inclusion of phrases of positive encouragement such as, "'Great job!', 'You did it!', 'Nice effort!', and 'You're a champ!'".

Administration

Participants accessed the exercise training program through their personal Power Braining account and completed each video in-home. It is important to note that as a consequence to the online/at-home nature of this study, *learner autonomy*[39] was supported through participant's choice of when (day/time), frequency, duration, dosing, and location of video completion. Although ultimately dependent upon the participant's discretion, it was strongly recommended that participants complete 2-3 videos per week, with at least one rest day in between. Each 30-35 minute video was completed at any time of day and in any (safe) area of the home. Finally, each participant received a weekly call or email from his or her assigned research assistant to check-in on progress and address any questions or concerns.

Treatment Fidelity

Participants received access to the same intervention videos via their own personal accounts. During the intervention, research assistants contacted participants each week via phone or email to provide them the opportunity to have any questions, concerns or comments regarding the training program addressed. Details of communications were only shared with members of the research team and appropriate actions were taken when necessary. While it was not encouraged for purposes of this study, participants did have the ability to rewind and/or repeat training videos. However, research assistants had back-end access to the Power Braining website with the ability to see 1) date/time each participants views a video, 2) which video is viewed, and 3) how long it was played. This data allowed the research team to have an idea of the pace of video completion for each participant and if a reminder to try to stay on track was appropriate.

Data Collection Procedures

Blinding

Blinding was not used in this study for neither subjects nor assessors. Subjects could not be blinded as the program required active participation and subjects would be aware if not included as part of the treatment intervention. Consequently, assessors could not be blinded since there was not an equivalent sham group.

Cultural Competence

This study was open to all individuals who met the inclusion and exclusion criteria regardless of ethnicity, religious affiliations, education, gender, or sexual orientation. Due to the English language used to provide verbal instructions of exercises in the video training program, conversational understanding of English was a requirement.

Ethics

The study was reviewed and approved by the George Mason Institutional Review Board (reference number at IRBNET.com 1713399-1) and registered on ClinicalTrials.gov (identifier NCT047096870). The study also followed the proposed principles and guidance for ethical conduct in clinical trials established in the World Health Organization's Clinical Health Guidelines[70] and the World Medical Association Declaration of Helsinki.[71]

Participant Safety

Participant safety was a top priority as the COVID epidemic forced all interactions with participants including data collection and intervention to be online. Prior to beginning training, participants were told to prioritize their personal safety above the interest of the study. The exercise training program was self-paced, and participants may have rested at any time during the activity. Participants may have also stopped the testing or the training at any time. The risk of slips, trips, and falls during assessment and training was mitigated by allowing the participant to be within reach of a chair, counter, or wall during each session. Furthermore, training videos offered seated alternatives to balance exercises if standing was too difficult. Research assistants conducted weekly check-ins to address safety or other patient concerns.

Data Management

All data collected was securely stored on the REDCap platform. Data was password-protected and only accessible to the principal investigator and members of the research team. All REDCap data were stored on the secure server maintained by DSHI (the Center for Discovery Science and Health Informatics), which is HIPAA compliant. Information contained in the database spreadsheet was identifiable only by a unique identification number. The identification number and data were accessible only to members of the study team. In agreement with participants, team members conducting virtual assessments ensured privacy by using a designated private room outside the line of sight of others not on the research team. Participants selected a private area of their residence.

Power and Sample Size

Relevant data to accurately base the sample size on the primary outcome, balance, was not found in the literature. Sample size for a paired t-test was thereby determined using a calculation based on an effect size of 0.6. Accounting for a 10% anticipated drop-out rate, a sample size of 23 participants was estimated as necessary to achieve a power of 80% and a level of significance of 5% (one-tailed), for detecting an effect size of 0.6 between pairs.

DATA ANALYSIS

Raw data was initially imported from the REDCap platform into Microsoft Excel 16 to process and score the IPAQ data according to the protocol in the published scoring manual. All data was then imported into Stata/BE 17.0 (Stata Corp., College Station, Texas, USA) for statistical analyses ($\alpha = 0.05$). The Shapiro-Wilk test was performed on each outcome variable to examine normality of distribution. The normality of distributions was then visually verified using normal quantile plots. Data was normally distributed for the OPTIMAL confidence scale score and CD-RISC score and non-normally distributed for tandem stance, SLS, ABC Scale and IPAQ. For aim 1, paired t-tests were used on the normally distributed outcomes and Wilcoxon signed-rank tests were used on the non-normally distributed outcomes to determine the effect of training on balance, self-efficacy, resilience, and physical activity. Effect sizes were also calculated. Equation 1 was used for parametric data and equation 2 was used for non-parametric data. To answer aim 2, Pearson's correlation coefficients were calculated to determine the strength of associations among self-efficacy and resilience with balance and physical activity before and after training program.

Equation 1 Cohen's d (unbiased)

$$\left(1 - \frac{3}{\left(4\left(2(n-1)\right) - 1\right)}\right) \times \left(\frac{Mpre - Mpost}{\sqrt{\frac{S^2pre + \ S^2post}{2}}}\right)$$

Equation 2 Effect size (r)

$$\frac{Z}{\sqrt{N}}$$

RESULTS

Out of 29 individuals who were screened for this study, 27 individuals were enrolled in this study. One participant sustained an unrelated leg injury prior to beginning the intervention and ultimately decided not to participate. Four participants dropped out of the study before completing ten training sessions, one of which cited difficulty with the time commitment, one citing personal issues, and two for non-adherence to intervention. Therefore, 22 participants were included in the final analysis. Participant characteristics are outlined in Table 4. No adverse events occurred during the intervention.

Table 4 Sample Characteristics

Characteristic		Value
Age		75 (64-80)
Sex	Male	5
	Female	17
Race	White	22
	Non-white	0
Education	Attended college, did not graduate	1
	College graduate	4
	Completed	17

	Graduate school	
Location	resident ILC	5
	member ILC	13
	non-member	2
	unknown	2

ILC = independent living community; members are part of the social community but do not live there

Changes in Balance, Self-Efficacy, Resilience and Total Physical Activity

A summary of the baseline means and changes in baseline after intervention for all of the outcome variables are displayed in Table 5.

Table 5 Summary of findings

Measure	Baseline mean (SD)	95% CI	Final mean (SD)	95% CI	Baseline-Final Change	95% CI	Standardized Effect Size	P-value
Tandem	8.8 (2.4)	[7.7, 9.8]	9.6 (1.4)	[9.0, 10.2]	0.8 (2.0)	[-0.1, 1.7]	0.475	0.026
SLS	17.3 (12.0)	[12.0, 22.7]	22.1 (9.5)	[17.8, 26.3]	4.7 (7.6)	[1.4, 8.1]	0.624	0.003
ABC	87.2 (10.5)	[82.6, 91.9]	88.3 (9.7)	[84.0, 92.7]	1.1 (4.7)	[-1.0, 3.1]	0.215	0.314
OPTIMAL	64.2 (10.8)	[59.4, 69.0]	64 (12.0)	[58.7, 69.3]	-0.2 (8.2)	[-3.8, 3.4]	-0.015	0.541
CD-RISC	78.1 (10.9)	[73.3, 83.0]	80.3 (9.5)	[76.1, 84.5]	2.2 (4.2)	[0.3, 4.1]	0.211	0.011
IPAQ	4105.4 (3195.1)	[2688.7, 5522.0]	4274.4 (3265.3)	[2826.6, 5722.2]	169.0 (3773.3)	[-1504.0, 1842.0]	0.045	0.833

SLS= Single leg stance (measured in seconds); ABC= Activities-Specific Balance Confidence scale; OPTIMAL= Outpatient Physical Therapy Improvement in Movement

Assessment Log; CD-RISC= Connor-Davidson Resilience Scale; IPAQ= International Physical Activity Questionnaire (measured in MET-minutes/week)

Balance

As shown in Table 5*,* balance increased for both measures between baseline and final. It should also be noted that all but five participants were at the 10 second mark for tandem stance at baseline (Figure 3) while slightly more than half of the participants (n=12) were at the 30 second mark for SLS (Figure 4). A Wilcoxon sign-rank test showed a significant difference between baseline and final tandem scores, with a p-value= 0.026, z= 2.23, effect size r= 0.475. A Wilcoxon sign-rank test identified a significant difference between baseline and final single leg stance scores, with a p-value= 0.003, z= 2.928, effect size r= 0.624.

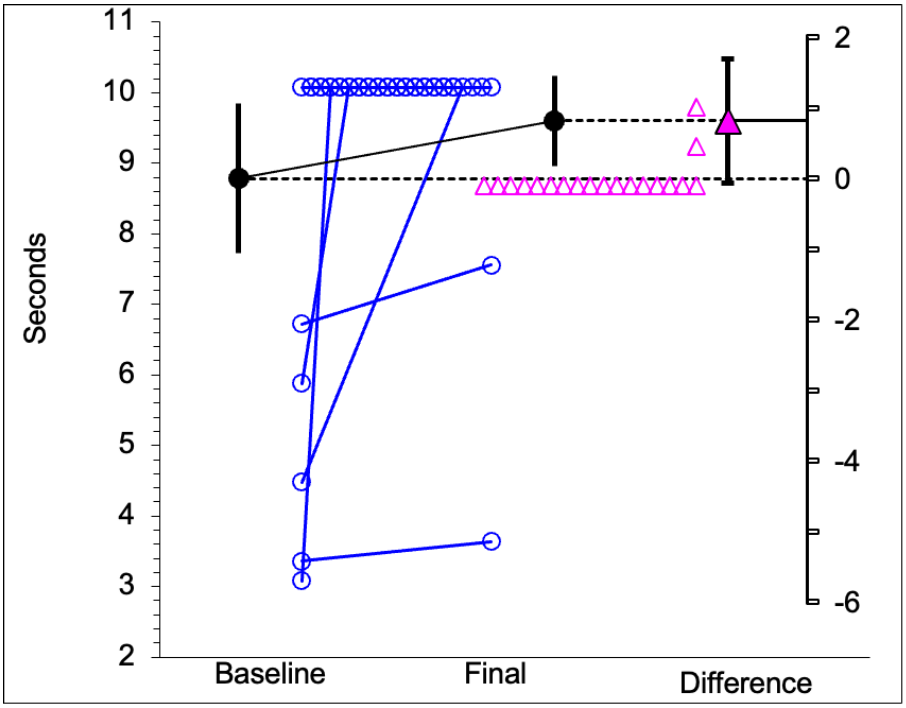

Figure 3 Change in Tandem Stance

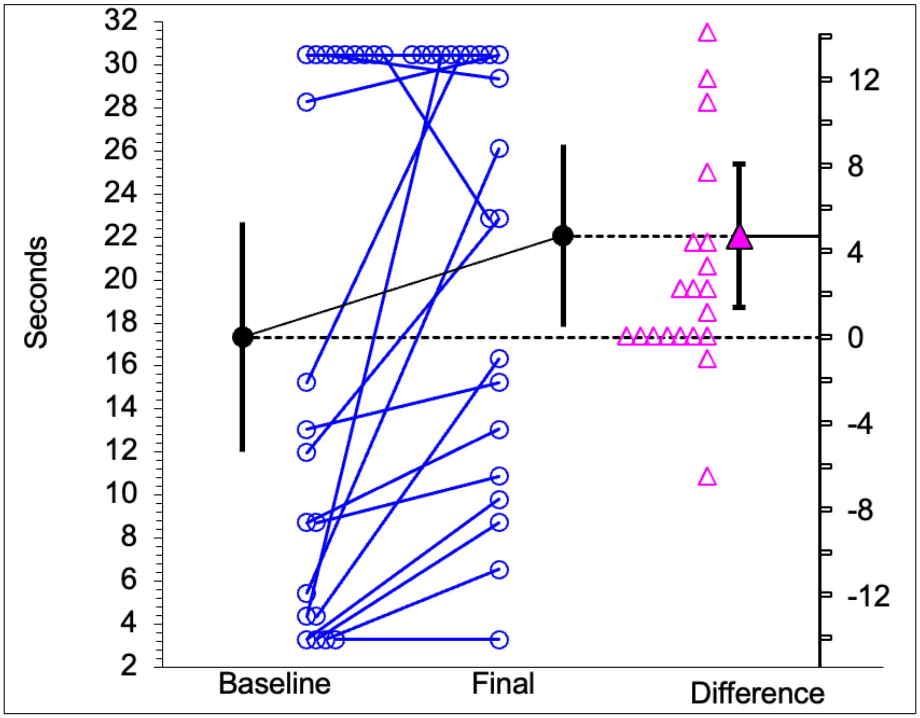

Figure 4 Change in Single Leg Stance

Figures 3 and 4: Each graph shows changes in outcome measures between baseline and final for each participant for tandem stance and SLS, respectively. Individual changes are displayed with blue lines connecting hollow blue circles. Changes from baseline for each participant are displayed by hollow pink triangles. Mean change from baseline and it's CI are displayed with a solid pink triangle and black bars.

Self-Efficacy

As displayed in Table 5, a Wilcoxon sign-rank test indicated a non-significant change between baseline and final ABC scores (Figure 5), with a p-value= 0.314, z= 1.007, effect size r= 0.215. Results of a paired t-test indicated a non-significant negligible difference between baseline and final OPTIMAL scores (Figure 6), with a p-value= 0.541, mean difference= -0.182, SD= 8.157, 95% CI [3.798, 3.435], effect size d= -0.015.

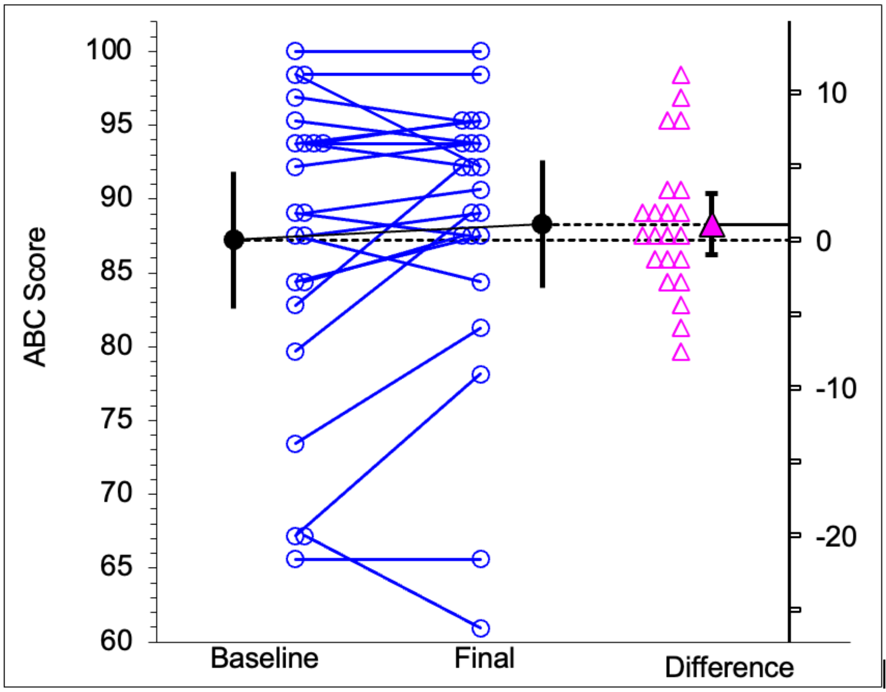

Figure 5 Change in Activities-Specific Balance Confidence Score

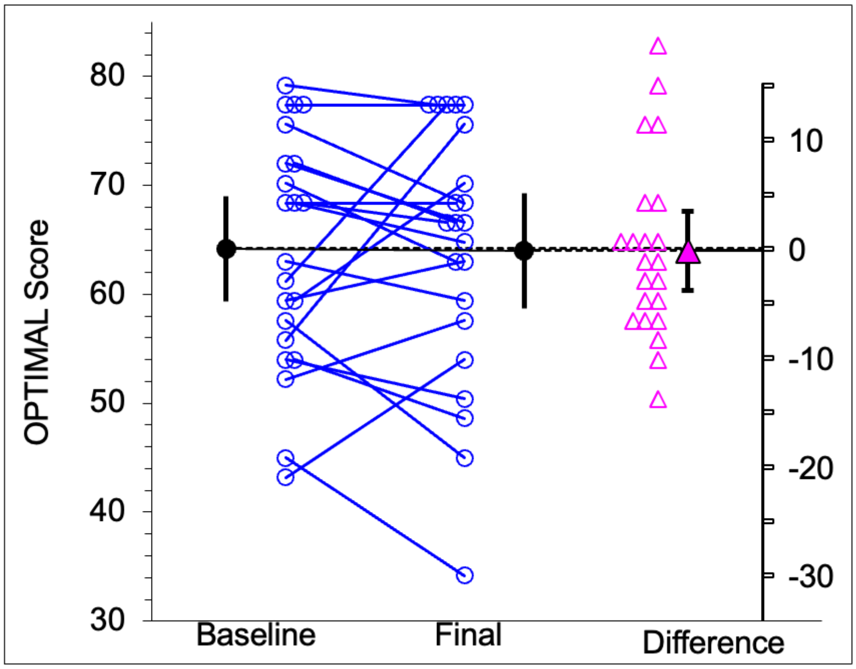

Figure 6 Change in OPTIMAL Score

Figures 5 and 6: Each graph shows changes in outcome measures between baseline and final for each participant for ABC and OPTIMAL, respectively. Individual changes are displayed with blue lines connecting hollow blue circles. Changes from baseline for each participant are displayed by hollow pink triangles. Mean change from baseline and it's CI are displayed with a solid pink triangle and black bars.

Resilience

As displayed in Table 5, resilience increased between baseline and final measures. A paired t-test identified a significant small difference between baseline and final CD-RISC scores (Figure 7), with a p-value= 0.011, mean difference= 2.227, SD=4.241, 95%CI [0.347, 4.108], effect size d= 0.211.

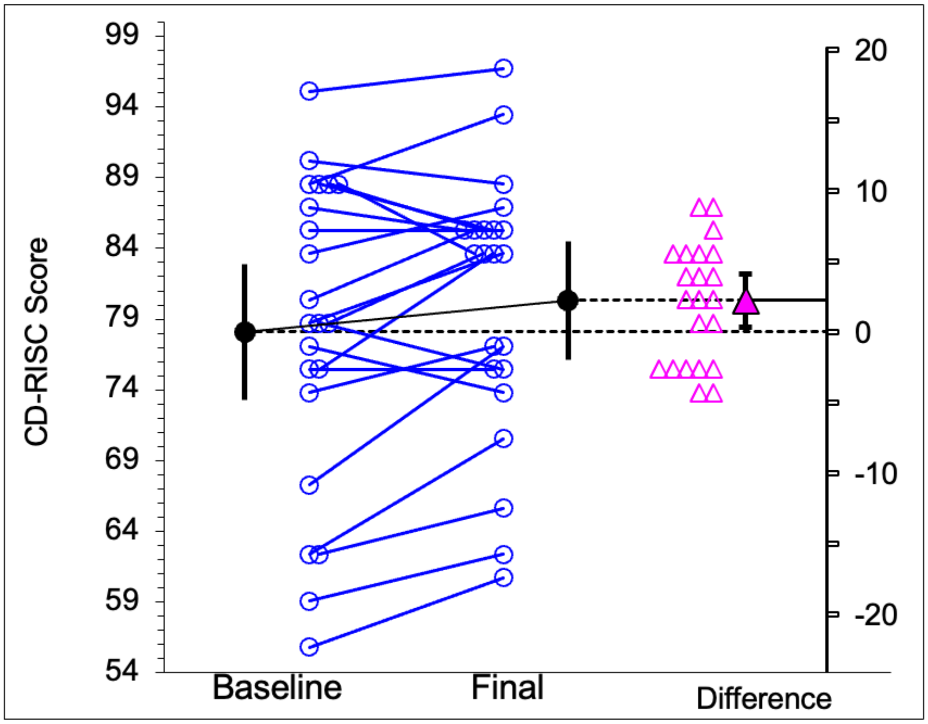

Figure 7 Change in CD-RISC Score

Figure 7 above shows changes in outcome measures between baseline and final for each participant for the CD-RISC. Individual changes are displayed with blue lines connecting hollow blue circles. Changes from baseline for each participant are displayed by hollow pink triangles. Mean change from baseline and it's CI are displayed with a solid pink triangle and black bars

Total Physical Activity

As shown in Table 5, there was a non-significant increase between baseline total physical activity and final physical activity (Figure 8). A Wilcoxon sign-rank test showed a non-significant trivial change between baseline and final total physical activity scores, with a p-value=0.833, z= 0.211, effect size r= 0.045.

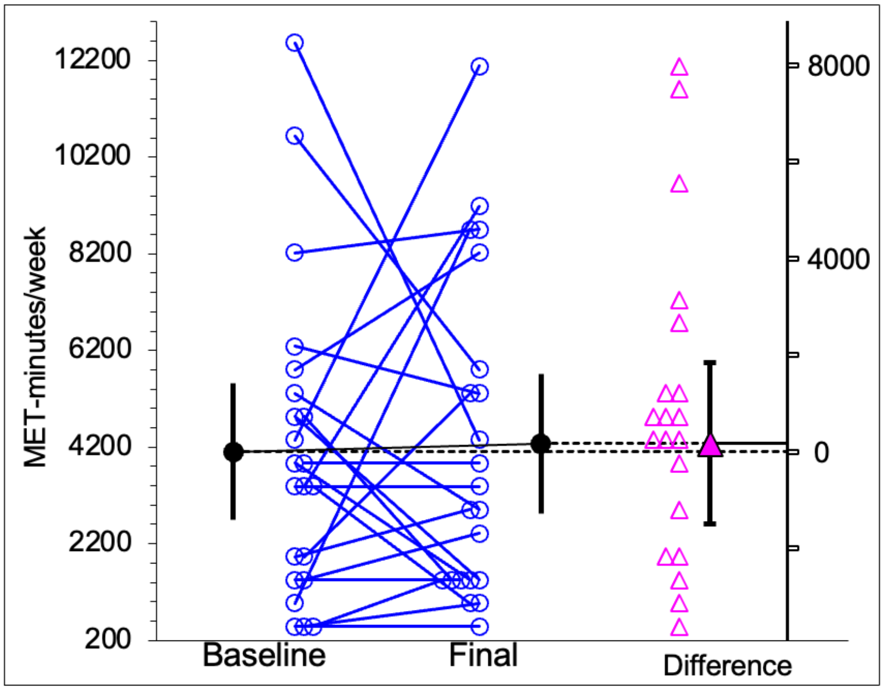

Figure 8 Change in Total Physical Activity

Figure 8 above shows changes in outcome measures between baseline and final for each participant for the IPAQ. Individual changes are displayed with blue lines connecting hollow blue circles. Changes from baseline for each participant are displayed by hollow pink triangles. Mean change from baseline and it's CI are displayed with a solid pink triangle and black bars.

Correlations between Self-Efficacy and Resilience with Balance and Total Physical Activity Before and After the Training Program

As displayed in Table 6, modest correlations were found between SLS and IPAQ measures at both baseline and final, final ABC and SLS measures, and final CD-RISC and IPAQ measures. Negative correlations were found between baseline CD-RISC and SLS measures, final ABC and tandem measures, final OPTIMAL and SLS measures, and final OPTIMAL and IPAQ measures. Additionally, strength of correlations increased slightly between baseline and final measures for ABC and SLS, OPTIMAL and IPAQ, CD-RISC and tandem, CD-RISC and SLS, and CD-RISC and IPAQ. Interestingly, the directionality of the correlations between baseline and final "flipped" for ABC and tandem, OPTIMAL and SLS, OPTIMAL and IPAQ, and CD-RISC and SLS.

Table 6 Correlations between self-efficacy and resilience with balance and physical activity before and after the training program

Measures		**Baseline r =**	**Final r =**
ABC	***Tandem***	0.1	-0.11
ABC	***SLS***	0.35	0.42
ABC	***IPAQ***	0.16	0.001
OPTIMAL	***Tandem***	0.30	0.01
OPTIMAL	***SLS***	0.05	-0.01
OPTIMAL	***IPAQ***	0.07	-0.12
CD-RISC	***Tandem***	0.07	0.13
CD-RISC	***SLS***	-0.12	0.25
CD-RISC	***IPAQ***	0.25	0.47
Tandem	***IPAQ***	0.27	0.18
SLS	***IPAQ***	0.59	0.45

DISCUSSION

The purpose of this study was to examine the effect of a 30-minute, 3 times per week, 24-session in-home online movement exercise program on balance, physical activity, self-efficacy, and resilience in older adults and community-based older adults. The results of the study indicate a significant moderate effect on tandem stance and SLS as well as a significant small effect on resilience. Self-efficacy and physical activity effect sizes were negligible to small and nonsignificant. The correlations among balance, self-efficacy, resilience, and physical activity were weak to moderate without discernible trends in changes of magnitude or direction.

The improvement in balance coincides with studies offering support that motor learning programs can ameliorate balance impairment in healthy community-dwelling adults and older adults.[7,16,17] Additionally, the balance improvement lends some support to incorporating learner autonomy and enhanced expectancies in a motor training program,[27,28,40] although this study did not include a comparison to a balance intervention. Without these features, further research is necessary to confirm the validity of this inference.

The small effect of training on resilience found in this study is consistent with studies of the importance of these psychological factors in the success of balance and physical activity programs.[20–23] Although previous studies suggest that increased physical activity is associated with increased resilience[33,35] and resilience showed a significant small increase after training in this study, physical activity did not increase in our participants. To the best of our knowledge, this is the first study reporting a concurrent investigation of the relationships among self-efficacy and balance, self-efficacy and physical activity, resilience and balance, and resilience and physical activity after training. These relationships are important to the field of rehabilitation as the factors should be targets of modification to encourage best outcomes for the patient. However, further elucidation of these relationships must be made before specific conclusions can be drawn.

Many individuals entered the program with unusually high scores on self-efficacy and balance assessments, indicating high functioning. Both balance measures and self-efficacy measures had very high baseline scores, leaving little to no room for improvement. Additionally, self-efficacy may not have increased due to participants having a different frame of reference of their balance abilities after the intervention, meaning they overestimated their abilities at the beginning. Moreover, this study did not account for the physiological impacts on self-efficacy. According to Bandura, one of the four sources of self-efficacy is physiological state. An individual in an adverse physiological state perhaps brought on by testing anxiety may exhibit increased heart rate, blood pressure, sweating, body temperature, and/or dryness in mouth may lower self-efficacy.[26] An adverse physiological state might also have affected those participants who scored lower after training.

Additionally, the results of this study regarding physical activity indicated several participants physical activity levels decreased between baseline and final measures, which is contrary to what is found in the literature.[72] This is surprising as participation in this program could have been viewed as an addition of a physical activity program into an individual's routine. Perhaps these participants who decreased may not have exerted themselves as vigorously, and therefore classified their time spent in the training sessions as low physical activity. Additionally, if the individual's self-efficacy decreased or did not improve, this may have contributed to a decrease in physical activity.

SUMMARY

Overall, specific aim 1 had four hypotheses related to the outcomes of interest. Of these, hypotheses 1, 3 and 4 were supported, and hypothesis 2 was partially supported. Specific aim 2 also had four hypotheses. Of these, hypotheses 2 and 4 were supported, and hypotheses 1 and 3 were partially supported. These results are displayed in Table 7.

Our results suggest that the training program had moderate effects on balance, and small effects on resilience. Additionally, correlations between pre- and post-training improvements also indicate that relationships among balance, self-efficacy and resilience and physical activity are mostly positive but modest at best, thus challenging easy interpretation.

Table 7 Summary of Hypotheses

Aim/ Hypothesis Number	**Hypothesis**	**Effect size Small/ moderate/ large**	**Hypothesis Supported by Results?**
Aim 1 H1	Balance will improve as measured by the last two items of the 4-Stage Balance Test (length of time in tandem stance and single-leg stance).	Moderate	Tandem: Yes
		Moderate	SLS: Yes
Aim 1 H2	Self-efficacy will increase as measured by the Activities-Specific Balance Confidence (ABC) Scale	Small	ABC: Yes

	and the confidence section of the Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) instrument.	Negligible	OPTIMAL: No
Aim 1 H3	Resilience will increase as measured by the Connor-Davidson Resilience Scale.	Medium	Yes
Aim 1 H4	Physical activity will increase as measured by the International Physical Activity Questionnaire.	Trivial	No
Aim 2 H1	Self-efficacy and resilience before the training program will be positively associated with balance and physical activity before training.		ABC – Tandem: Yes
			ABC – SLS: Yes
			ABC – IPAQ: Yes
			OPTIMAL – Tandem: Yes
			OPTIMAL – SLS: Yes
			OPTIMAL – IPAQ: Yes
			CD-RISC – Tandem: Yes
			CD-RISC – SLS: No
			CD-RISC – IPAQ: Yes
Aim 2 H2	Balance before the training program will be positively associated with physical activity before training.		Tandem: Yes
			SLS: Yes
Aim 2 H3	Self-efficacy and resilience after the training program will be positively associated with balance and physical activity after training.		ABC – Tandem: No
			ABC – SLS: Yes
			ABC – IPAQ: Yes
			OPTIMAL – Tandem: Yes
			OPTIMAL – SLS: No
			OPTIMAL –

			IPAQ: No
			CD-RISC – Tandem: Yes
			CD-RISC – SLS: Yes
			CD-RISC – IPAQ: Yes
Aim 2 H4	Balance after training will be positively associated with physical activity after training.		Tandem – IPAQ: Yes
			SLS – IPAQ: Yes

LIMITATIONS

Due to the COVID-19 pandemic, all assessments and the intervention were completed online. It is important to note while these assessments were not originally validated for virtual administration, the research team developed the online surveys by closely following guidelines outlined by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) task force for equivalence between electronic and paper-based patient-reported outcomes (PRO)[57] in attempt to emulate paper-based assessments. Furthermore, because the intervention videos were completed without the presence of a research assistant and at the ultimate discretion of each participant, specific parameters for exercise training may remain uncertain such as dosing, intensity, duration, and frequency. As with all pre-experimental designs, the lack of a control group limits generalizability, compounded by small sample size. Additionally, there is also multiple testing on a small number of subjects which increases the risk of spurious positive findings (Type 1 error). Selection bias may have also been a factor, as the individuals who volunteered to participate were highly motivated to do so, and the findings suggest that a high level of functioning may have made it less likely to demonstrate gains from training.

CONCLUSIONS

This study provides preliminary evidence of the effects on an in-home online movement exercise program to improve balance and resilience. Further research on a more diverse population is needed to test the effectiveness of this training program as well as elucidate the complex interrelationships explored in this study.

APPENDIX

Approved Dissertation Proposal

DEPARTMENT OF REHABILITATION SCIENCE DISSERTATION COMMITTEE AND PROPOSAL APPROVAL FORM

Student: EMILY M. LEONARD

Proposal Title: THE IMPACT OF AN ONLINE MOVEMENT TRAINING PROGRAM FOR COMMUNITY-BASED ADULTS AND OLDER ADULTS ON BALANCE, PHYSICAL ACTIVITY, SELF-EFFICACY AND RESILIENCE

Proposed Committee:

________________________________ Rosemary D. Higgins, MD, Chair

________________________________ Andrew A. Guccione, PT, PhD, DPT, FAPTA, Co-Chair

________________________________ Hua Min, PhD, Committee Member

________________________________ Margaret T. Jones, PhD, Committee Member

________________________________ Julie D. Ries, PT, PhD, External Reader

__________________________________ Rosemary D. Higgins, MD, Interim Department Chair

Date: ___December 11, 2021___________ Fall 2021
George Mason University
Fairfax, VA

ABSTRACT

Objective: To examine the effects of a 30-minute, 3 times per week, 24-session at home online movement exercise program on balance, physical activity, self-efficacy, and resilience in community-based and older adults.

Background:
Balance impairment is a commonly reported consequence of the normal aging process. It may lead to falls, serious injuries, and physical activity avoidance. Moreover, these sequelae may worsen when balance impairments work in concert with the psychological factors of decreased self-efficacy and resilience. Fortunately, existing evidence supports the use of movement training programs to improve balance in older adults. However, there are no known studies examining the impact of an online movement training program on balance, physical activity, self-efficacy, and resilience and associations among these factors in community-based and older adults. Wulf and Lewthwaite have proposed that *enhance expectancies* of future performance and factors that support *learner autonomy* are motivational factors that contribute to optimal motor learning and performance. It also presumes that expected success breeds further success and helps consolidate memories. Framed from this perspective, several critical relationships emerge among balance, physical activity, self-efficacy, and resilience which affect balance and physical activity after motor training that warrant further exploration.

Methods: Participants between the ages of 55-80 years of age will be recruited from the Washington, D.C. metro area, including senior independent living facilities. The target sample size for this study is 37 participants. Eligible participants will be asked to complete a total of 24 training sessions, 2-3 times per week for approximately 35 minutes each.

Outcome Measures: All participants will complete pre- and post-test measures of static balance using the 4-stage balance test, physical activity using the International Physical Activity Questionnaire, self-efficacy using the OPTIMAL instrument and Activities-

Specific Balance Confidence Scale, and resilience using the Connor-Davidson Resilience Scale.

Data Analysis: Statistical analysis will be completed using STATA IC version 15. For aim 1, comparison of means pre- and post-training will be performed using a paired t-test with a significance level of $p \leq 0.05$ to determine if there was significant improvement in balance, physical activity, self-efficacy, and resilience. For aim 2, a multiple linear regression model will be used to determine the extent to which self-efficacy and resilience are associated with balance and physical activity before and after training.

SPECIFIC AIMS

Throughout the normal aging process, musculoskeletal and sensory changes occur, leaving older adults at higher risk for balance impairment and subsequent decreased self-efficacy (SE) in physical activity (PA) engagement. Thus, PA levels are likely to decrease, which leads to deconditioning, diminished lower body strength, and even greater vulnerability to falls and subsequent injuries. More than one out of every four older adults experience a fall each year, each time doubling the likelihood of falling again. About one third of older adults who experience a fall, even if uninjured, develop a fear of falling. This fear has been associated with poorer balance performance and often prompts a person to avoid participating in daily and physical activities all together. Ultimately, balance impairments accompanied by decreased SE and resilience may lead to loss of independence, and poor quality of life. Existing evidence supports the use of movement training programs to improve balance in older adults, but individuals with low self-efficacy and balance impairment are less likely to participate in such programs.

Moreover, the literature suggests balance interventions that encourage and promote self-efficacy are more effective than those not grounded in promotion of self-efficacy. Thus, an online movement training program based on the promotion of self-efficacy should be positively with the amelioration of balance impairment for individuals. Wulf and Lewthwaite have proposed a theory of motor learning that conditions that *enhance expectancies* of future performance and factors that support *learner autonomy* are motivational factors that contribute to optimal motor learning and performance. It also presumes that expected success breeds further success and helps consolidate memories. Thus, psychological factors such as self-efficacy, defined by Bandura (1977) as an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments, and resilience which describes a person's physical and psychological ability to thrive in the face of adversity. Framed from this perspective, several critical relationships emerge among balance, physical activity, self-efficacy, and resilience which affect balance and physical activity after motor training that warrant further exploration.

To address this critical need, the overarching research question of the study is: What is the impact of an online movement training program on the relationships among balance, physical activity, self-efficacy, and resilience in healthy, community-dwelling older adults? This will be answered using the following specific aims and hypotheses:

Aim 1: To determine the effect of an 8-week virtual Brain and Balance (BAB) training program on balance, self-efficacy, resilience, and physical activity in community-dwelling adults and older adults.

H1: Balance will improve as measured by the last two items of the 4-Stage Balance Test (length of time in tandem stance and single-leg stance).

H2: Self-efficacy will increase as measured by the Activities-Specific Balance Confidence (ABC) Scale and the confidence section of the Outpatient Physical Therapy Improvement in Movement Assessment Log (OPTIMAL) instrument.
H3: Resilience will increase as measured by the Connor-Davidson Resilience Scale.
H4: Physical activity will increase as measured by the International Physical Activity Questionnaire.

Aim 2: To determine the extent to which self-efficacy and resilience are associated with balance and physical activity before and after the BAB training program in community-dwelling adults and older adults.
H1: Self-efficacy and resilience before BAB will be significantly associated with balance and physical activity before BAB.
H2: Self-efficacy after BAB will be significantly associated with balance and physical activity after BAB.
H3: Resilience after BAB will be significantly associated balance and physical activity after BAB.
H4: Balance after BAB will be significantly associated with physical activity after BAB.

Investigation into a online movement training program to ameliorate balance impairment will provide clinicians with insight into a more accessible approach to movement training while addressing other factors that contribute to a healthier and improved quality of life. Clinicians may use findings of this study to increase outreach among the older community.

BACKGROUND/ SIGNIFICANCE

Among numerous factors influencing the health of older adults (aged 65 years and older), a fall is a major event that may result in various functional, social, and psychological consequences. Falls are the leading source of fatal and nonfatal injury in older adults in the United States.[2,3] More than one out of every four older adults experience a fall each year, each time doubling the likelihood of falling again.[3,4] In 2018, falls among older adults resulted in 3 million emergency department visits, 950,000 hospitalizations and 32,000 deaths caused by fall-related injuries. Furthermore, it was estimated that in 2015 the total medical costs attributable to both fatal and nonfatal falls in the US was $50 billion.[73]

Throughout the normal aging process, musculoskeletal and sensory changes including joint stiffness, muscle atrophy, reduced ability to contract muscles, changes in gait, and vision disorders occur, leaving older adults at higher risk for balance impairment and subsequent decreased self-efficacy (SE) in physical activity (PA) engagement.[50] Thus, PA levels are likely to decrease,[74,75] which leads to deconditioning, diminished lower body strength, and even greater vulnerability to falls and subsequent injuries.[12] About one third of older adults who experience a fall, even if uninjured, develop a fear of falling.[10] This fear has been associated with poorer balance performance[11] and often prompts a person to avoid participating in daily and physical activities all together.[10] Ultimately, balance impairment may contribute to decreased SE and resilience, loss of independence, and poor quality of life.[52–54] Given the high incidence of falls and their severe repercussions, investigation into an easily accessible, online motor learning intervention to improve balance and increase physical activity, self-efficacy, and resilience in older adults is critical.

Motor learning is defined as "the study of the acquisition and/or modification of skilled action".[38] Over the last century, the dominant viewpoint among numerous motor learning theories was that motor learning is enhanced when practice conditions make information processing more challenging.[39] In 2016, Wulf and Lewthwaite proposed the OPTIMAL (Optimizing Performance through Intrinsic Motivation and Attention for Learning) theory of motor learning, which was the first motor learning theory to take into account the mounting evidence implicating the role of motivational and attentional influences on motor learning and performance.[39] The OPTIMAL theory asserts that the two key motivational variables of *enhanced expectancies* of future performance and *learner autonomy*, along with *external focus of attention,* are crucial for optimal motor learning and performance. Building on Bandura's self-efficacy theory,[25] Wulf and Lewthwaite assert that expectations of success or failure predict future performance. Performance expectancies are determined by previous performance outcomes and can be enhanced through conditions that support positive feedback, lessen perceived task difficulty, increase conceptions of ability, and amplify positive affect.[39] Furthermore, providing learner autonomy by allowing individuals to exercise control over the environment enhances motivation, as it gives the learner some control of upcoming tasks.[39] Finally, conditions that enhance an external focus of attention on the intended movement effect is more conducive to motor learning compared to an internal (body) focus of attention.[39] For purposes of this study, *enhanced expectancy* and *learner autonomy* will be the two factors employed to optimize motor learning of balance.

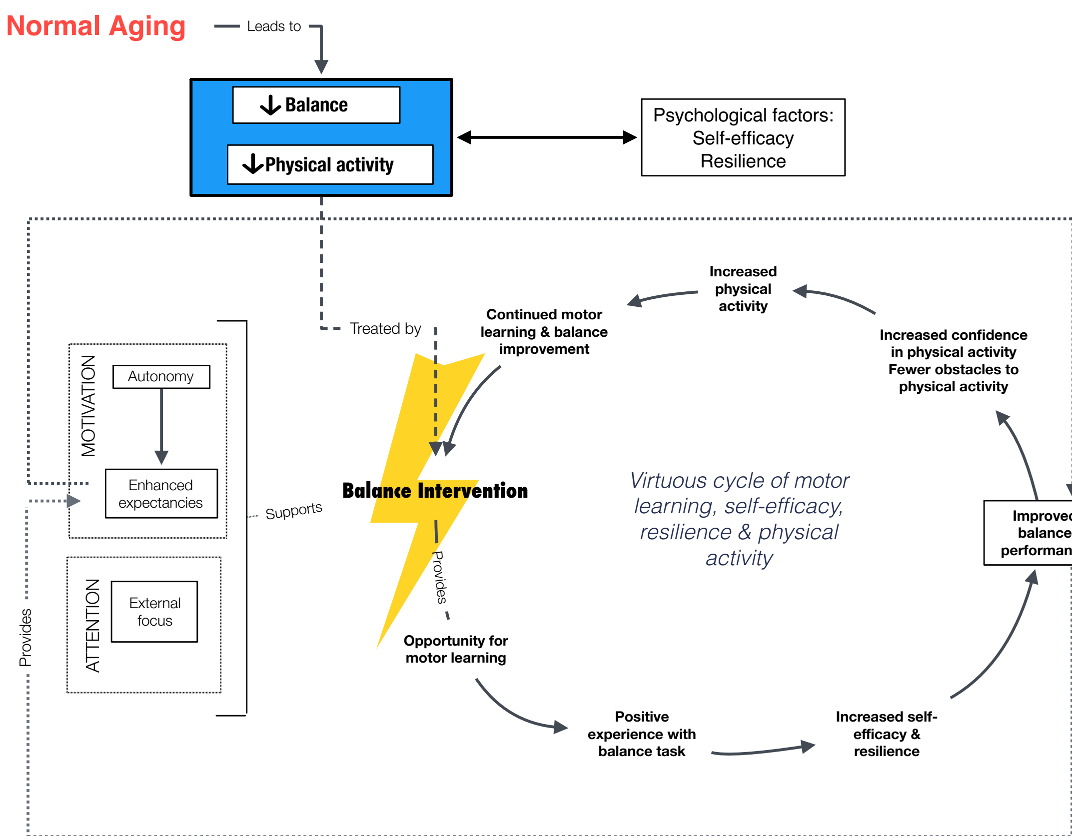

Figure 9: Theoretical Framework

Figure 1 illustrates the theoretical framework of which this study is based upon, applying elements of the OPTIMAL theory of motor learning to explain and predict the virtuous cycle and relationships among motor learning, PA, and influential psychological factors that may occur during a successful balance training intervention. To begin, participation in a balance training intervention that enhances expectancies and supports autonomy provides the opportunity for motor learning.[39] When an individual has a positive experience with a balance task, the feeling of intrinsic reward increases self-efficacy and enhances expectations of success for future performance.[39] This positive experience and self-efficacy boost is critical to motor learning as it is a major factor in predicting continued intervention participation among older adults.[37,41] As balance improves, confidence in PA continues to grow, fewer obstacles to PA are perceived,[76] and resilience is strengthened. Increased PA provides additional opportunity for motor learning,[49] and balance continues to improve further. The above self-reinforcing cycle is predicted to endure throughout the balance intervention.

According to the literature, resilience is a contributing factor to successful aging and quality of life.[31,32,36,77] Resilience describes a person's physical and psychological ability to recover and thrive in the face of adversity. In a study on diabetes, it was found that individuals with higher resilience did not show increased diabetes-related distress as compared to individuals with lower resilience.[78] Resilience has also been found to improve after a rehabilitation program, [36] thus making it a target modifiable factor in rehabilitation.

The literature suggests balance interventions grounded in promotion of self-efficacy are more effective than those not grounded in promotion of self-efficacy.[27,28,29] Self-efficacy is a psychological construct introduced by Albert Bandura and is defined as, "belief in one's capabilities to organize and execute the courses of action required to produce given attainments".[25] According to the literature, the underlying neuromechanism that bridges the gap between self-efficacy and motor learning is dopamine.[39,42,43] The dopaminergic system has been identified as a major reward processor and one of its main targets is the striatum, a structure crucial to motor control.[43] When learning a motor task, it is believed that conditions that enhance expectancies and/or provide autonomy support stimulate a dopaminergic response, preparing the brain for learning and temporally linking the dopaminergic response to performance attempts.[39,43]

Structured motor learning programs offer multiple challenges that can eventually be mastered and provide multiple opportunities for participants to experience personal success arising from their own efforts, further enhancing self-efficacy and resilience. The literature also provides sufficient evidence supporting the significant roles of enhanced expectancies and learner autonomy in motor learning as outlined in the OPTIMAL theory. In three different studies, providing positive feedback of performance (whether true or false) or artificially inflating an individual's conception of ability both resulted in superior outcomes to the groups who did not receive conditions to enhance expectations.[27,28,44] Furthermore, it has been reported that giving learners choices about their environment, even ones incidental to the task, influence learning through satisfaction of a basic psychological need[39,45] and provide a sense of control over the upcoming tasks. Allowing learners to choose the duration or spacing of practice trials was found to result in more effective learning than the yoked control conditions.[46,47]

The literature suggests that balance impairment can be ameliorated through motor learning programs in healthy community-dwelling adults and older adults.[7,16,17] Unfortunately, one of the biggest issues discussed in the literature is patient initiation and retention of such motor training programs.[17,37] Interestingly, it has been reported that self-efficacy is not only the most important variable in predicting PA behavior,[20] but also a significant predictor of balance performance.[21] The literature supports that self-efficacy is one of the most consistent correlates to physical activity, functional limitations, and quality of life in older adults.[24] As explained by Bandura, an individual with low self-efficacy is less likely to exert optimal effort towards a task (physical activity) or persist in the face of difficulties,[26] especially if they are already struggling with balance impairment. Thus, the aim of the study is to investigate the impact of an easily accessible, online motor training program that employs positive aspects of the OPTIMAL theory on balance, physical activity, self-efficacy, and resilience and associations among these variables in healthy community-dwelling and older adults.

METHODS

Study Design This single-arm prospective pre-experimental study will consist of 24 virtual training sessions over an 8 to 12-week period with pre- and post-training assessments. We propose to test the hypothesis that *Brain and Balance*, a proprietary online program marketed under POWER BRAINing™ (The Braining Center, 2020), will improve balance, increase physical activity, self-efficacy, and resilience.

Target Population and Sample The target population for this study includes men and women, in generally good health, between the ages of 55 to 80 residing in the Virginia, Maryland and Washington D.C. area. The target sample will be a convenience sample of individuals who may or may not reside in an independent living facility.

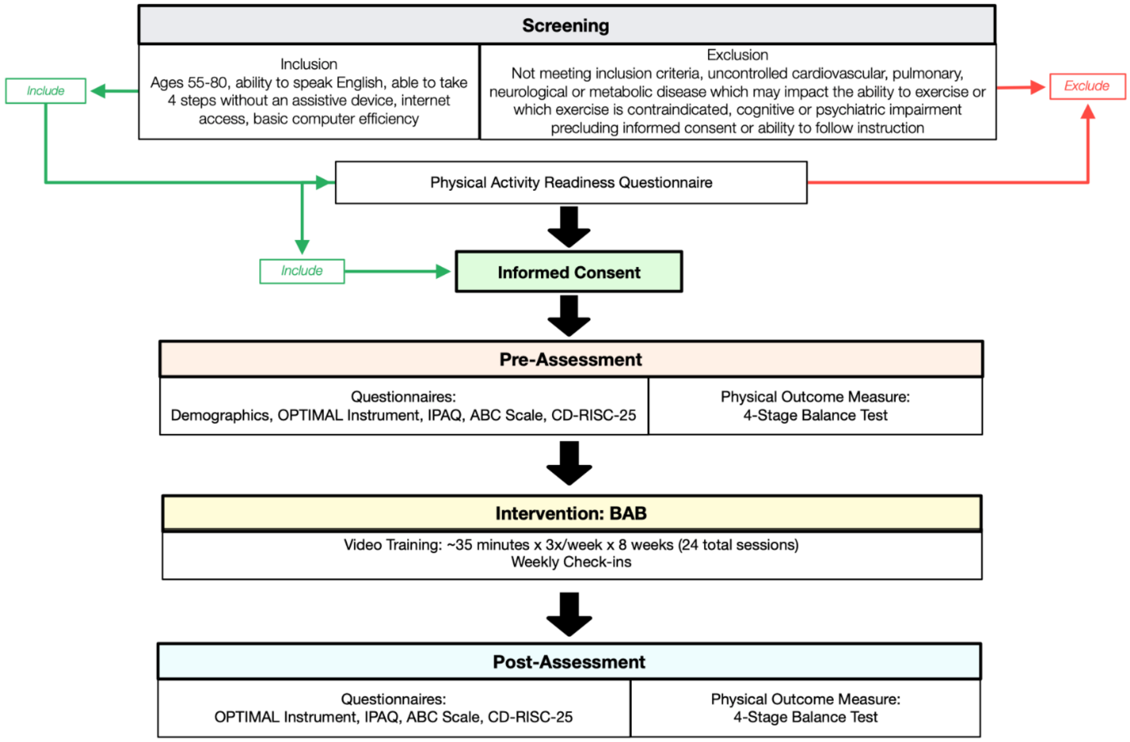

Figure 10: Schematic of Data Collection

Recruitment Participants will be recruited from the local community and from local independent senior living facilities through The Braining Center. Methods for recruitment will include advertisements through emails, flyers, social media, and word of mouth. Approval of all marketing materials will be obtained from appropriate personnel at the independent living facility prior to its distribution.

Participant Selection Prospective subjects will initiate contact with the research team by emailing the designated study email address. A research assistant will respond to the inquiry by answering any questions and, if interested, schedule a call to determine if the individual meets basic eligibility. During the call, the screening tool will be administered by the research assistant and recorded in the REDCap platform. This questionnaire is study-specific, developed to assess the eligibility criteria of inquiring individuals and provide standardized information regarding the purpose of this study.

Inclusion Criteria and Exclusion Criteria *Inclusion:* Individuals between 55-80 years who have the ability to take at least 4 steps without an assistive device and the ability to speak English and exhibit competence in basic computer skills. *Exclusion:* Not meeting inclusion criteria, the inability to ambulate at least 4 steps without an assistive device; uncontrolled cardiovascular, pulmonary, neurological, or metabolic disease (excluding obesity) which may impact the ability to exercise or in which exercise is contraindicated; or cognitive or psychiatric impairment precluding informed consent or ability to follow instructions. If an individual is deemed ineligible or declines participation in the study, his or her responses will not be recorded or used in the study.

Consent Procedures If an individual is determined eligible after completion of the screening tool and is interested, a research assistant will send an email to the participant containing a link to a scheduled Zoom videoconference and an unsigned copy of the informed consent for individual review. Once on the videoconference, the participant will receive a secure link to complete an electronic version of the Physical Activity Readiness Questionnaire (PAR-Q),[55] which will be used to assess an individual's physical fitness level and ability to engage in PA. If a participant meets all the inclusion and exclusion criteria, passes the PAR-Q, and elects to participate, the research assistant will send a secure link via Zoom containing the informed consent file that will be e-signed. The informed consent will be administered in accordance with the George Mason University Institutional Review Board. The research assistant will read aloud and explain the study rationale, procedures, risks, benefits, and voluntary participation. The participant will be given the opportunity to ask questions he or she may have. If the participant expresses understanding and agrees, he or she will be asked to electronically sign his/her name on the informed consent through the REDCap platform where it will be securely stored. Finally, the research assistant will schedule a second Zoom call for their virtual baseline assessment.

Intervention *Content:* This intervention is designed to improve cardiovascular endurance, cognitive performance, and balance performance. The intervention will consist of 24 online training classes with three sessions a week for 8-12 weeks (dependent on subject's pace). For each 35-minute class, subjects will follow the instructions and demonstrations provided by the virtual avatar to carry out the various exercises and tasks. Videos are presented in a progressively challenging manner for all domains. To promote cardiovascular conditioning the exercises are structured to keep the participant in motion while maintaining an elevated heart rate using techniques such as squats, marching and upper extremity movements. To promote cognitive performance, participants will be asked to complete simple and complex cognitive tasks, such as arithmetic, spatial memory recall and attention while completing the physical exercises.

Breakdown of Exercises in Video Intervention	***Total Length of Training over 24 Sessions***	***Average Length of Training per Class***
Warm Up	71:18:00	2:58:15
Heart Rate Variability Training	70:35:00	2:56:28
Balance Exercises	**27:56:00**	**1:09:50**
Cardio Cog	84:36:00	3:31:30
Dextercises	22:23:00	0:55:58
Visual Tracking	43:40:00	1:49:10

Balance & Squat Exercises	**86:58:00**	**3:37:25**
Rapid Reaction	83:24:00	3:28:30
Metronomic Timing Exercises w/ Cog Challenge - Hands based exercise	36:21:00	1:30:53
Metronomic Timing Exercises w/ Cog challenge- Lower body-based exercise	41:07:00	1:42:48
March Reminder (Cardio exercise w/ breathing training)	15:25:00	0:38:33
Power Ups	44:10:00	1:50:25
Seated Stretch	26:40:00	1:06:40
Mindfulness	83:51:00	3:29:38
Total Balance Exercises + Balance & Squat Exercises:	**114:54:00**	**4:47:15**
Total (all exercises):	**738:24:00**	**30:46:00**

Table 1: Durations of each exercise in video intervention (min:sec:milisec)

To promote balance performance, videos will progressively challenge subjects to perform movement tasks integrating narrower base of support exercises such as single leg stance or multi-planar movements versus single plane. For example, balance exercises include:

Video #	***Balance Exercise Description***
1	The avatar instructs the participant to: 4) stand on left leg, 5) make a star shape with the right leg by moving it forward, forward and right, to the right, backward and right, backward, and backward and left, 6) switch to other leg & repeat
12	The avatar instructs the participant to: 5) raise right leg, 6) clap above head, 7) clap below their lifted leg, *(Repeat steps 1-3 multiple times)* 8) switch to the other leg & repeat
24	The avatar instructs the participant to: 4) lift their right foot in front of them as high as possible and hold for 5 seconds, 5) lift their right foot behind them as high as possible and hold for 5 seconds, *(repeat each movement a few times)* 6) switch to the other leg & repeat

Table 2: Examples of balance exercises

Examples of balance and squat exercises include:

Video #	***Balance & Squat Exercise Description***
1	The avatar instructs participant to: 4) keep mouth closed with tongue on roof of mouth, 5) cross left arm under right arm, 6) perform a series of squats while focusing on breathing
12	The avatar instructs participant to: 6) place feet shoulder-width apart and facing same direction, 7) squat as far down as far as comfortably can, 8) balance on one foot 9) squat again 10) balance on other foot (*Repeat steps 1-5 multiple times)*
24	The avatar instructs participant to: 6) place feet shoulder-width apart and facing same direction, 7) squat as far down as far as comfortably can 8) balance on one foot 9) squat again 10) balance on other foot (*Repeat steps 1-5 multiple times)*

Table 3: Examples of balance & squat exercises

It is important to note that safety is emphasized in each balance exercise by offering the participant to choose to do the exercise in either a seated position, standing position, or alternative position standing behind a chair and holding onto it. Also, the balance and squat exercises emphasize safety by offering the participant to choose from either the seated position, the standing position, or an alternative of using a chair to squat down on. In addition to providing safety measures, these choices also provide *learner autonomy*[39] by allowing individuals to exercise control over the environment, thereby enhancing motivation as it gives the learner some control of the task at hand and may *enhance expectancies*[39] for future tasks. The videos may also enhance expectancies through the inclusion of phrases of positive encouragement such as, “Great job!”, “You did it!”, “Nice effort!”, and “You’re a champ!”.

Administration Participants will access the exercise training program through his or her personal Power Braining account and complete each video in his or her own home. It is important to note that as a consequence to the online/at-home nature of this study, *learner autonomy*[39] will be supported through participants’ choice of when (day/time), frequency, duration, dosing, and location of video completion. Although ultimately dependent upon the participant’s discretion, it will be strongly recommended that participants complete 2-3 videos per week, with at least one rest day in between. Each 30-35 minute video may be completed at any time of day and in any (safe) area of the home. While it is not encouraged for purposes of this study, participants will have the ability to rewind and/or repeat training videos. Finally, each participant will receive a weekly call or email from his or her assigned research assistant to check-in on progress and address any questions or concerns.

Treatment Fidelity Each participant will receive access to the same intervention videos via his or her own personal account. During the intervention, research assistants will contact subjects each week via phone or email to provide them the opportunity to have any questions, concerns or comments regarding the training program addressed. Details of communications will only be shared with members of the research team and appropriate actions will be taken when necessary. Furthermore, research assistants will have back-end access to the Power Braining website with the ability to see 1) date/time each subjects views a video, 2) which video is viewed, and 3) how long it was played. This data will allow the research team to have an idea of the pace of video completion for each subject and if a reminder to try to stay on track would be appropriate.

Assessment Instruments In addition to a demographics survey, the following assessments will be administered during the scheduled videoconferences using the Zoom and REDCap virtual platforms. Unique survey links will be securely sent to each participant through the Zoom chat box during the Zoom videoconference. Data will be securely stored within the REDCap platform and only be accessible by members of the research team. In addition to providing the written instructions included on questionnaires, the research assistants will provide specific verbal instructions and be present during each assessment to answer any questions. Baseline assessments will be completed within two weeks of consenting and final assessments will be completed within two weeks after finishing the intervention. Self-efficacy will be measured by e-versions of the Outpatient Physical Therapy Improvement in Movement Assessment Log and the Activities-Specific Balance Confidence Scale; physical activity will be measured using an e-version of the International Physical Activity Questionnaire; resilience will be measured using an e-version of the Connor-Davidson Resilience Scale; balance will be measured by the 4-Stage Balance Test via Zoom videoconference.

Outpatient Physical Therapy Improvement in Movement Assessment Log: The OPTIMAL Instrument[56] is a self-report assessment that measures difficulty and self-confidence in performing 22 movements that are necessary for an individual to accomplish various functional activities. For purposes of this study, only the questions from the "self-confidence" section of assessment will be asked since we are not interested in the "difficulty". The confidence scale of the OPTIMAL has been found to have high construct validity for the trunk (0.87), lower extremity (0.95), and upper extremity (0.95).[56] Minimal to moderate ceiling effects have been reported on some of the items on the OPTIMAL. Because an electronic version of the survey did not yet exist in REDCap, the research team developed the online survey by closely following guidelines outlined by the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) task force for equivalence between electronic and paper-based patient-reported outcomes (PRO).[57]

International Physical Activity Questionnaire Long The International Physical Activity Questionnaire Long (IPAQ)[58] is a 27-item self-report assessment of PA and can be used as continuous or categorical data. The IPAQ can be used in a clinical setting or to compare PA levels across populations internationally. Duration and frequency of PA is measured in the domains of 1) job-related, 2) transportation, 3) housework, house maintenance, caring for family, 4) recreation, sport, and leisure-time, and 5) time spent sitting. Additionally, subscores can be calculated for 1) walking, 2) moderate-intensity activity, 3) vigorous-intensity activity, and 4) each domain.[58] For purposes of this study, total PA (MET-minutes/week) will be calculated as a continuous variable using responses to all questions. The IPAQ has excellent test-retest reliability for overall score (ICC= 0.81),[58] and adequate concurrent validity for total time spent in physical activity, in combined vigorous and moderate physical activity compared to accelerometer monitoring ($\rho = 0.55$, $\rho = 0.36$).[59]

Activities-Specific Balance Confidence Scale The ABC Scale[60] is a 16-item self-report measuring participant's balance confidence in performing different activities without losing balance. Each question begins with, "How confident are you that you will not lose your balance or become unsteady when you…", to which subjects respond by selecting a score from 0% (no confidence) to 100% (completely confident). The ABC Scale has excellent test-retest reliability in the elderly population ($r = 0.92$, $p < 0.001$)[60] and excellent internal consistency in community-dwelling older adults (Cronbach's alpha = 0.96).[61] Additionally, the ABC Scale has been used as a valid measure of balance self-efficacy in several studies.[21,29,53,62]

Connor-Davidson Resilience Scale The Connor-Davidson Resilience Scale[63] (CD-RISC) self-reported scale consisting of 25 items measuring resilience with a theoretical foundation in stress, coping and adaptation research.[64] Subjects respond to each statement using a 5-point Likert scale, ranging from 0 (not true at all) to 4 (true nearly all the time). The CD-RISC has excellent internal consistency within the general population (Cronbach's alpha = 0.89) and excellent test-retest reliability ($r= 0.87$).[63]

4-Stage Balance Test The purpose of the 4-Stage Balance Test[65] (4SBT) is to assess static balance by holding four progressively more challenging positions. Participants will be allowed to rest their hands on a countertop, chair back, or wall while they position their feet as instructed by the research assistant. The four testing positions are: feet side-by-side, one foot placed with the instep touching the big toe of the other foot, tandem stance, and single limb stance. The goal is to maintain each of the first 3 positions for 10 seconds and the final position (single limb stance) for 30 seconds without using their hands for support or moving their feet. Before beginning the 4SBT, the subject will be asked to adjust their computer camera and position themself so that the research assistant can see a full view of them when standing. For purposes of this study, the focus will be on single limb stance and tandem stance.

Although unrelated to the aims of this study, additional assessments will be used to measure changes in attention and auditory working memory, visual spatial working memory, information processing speed, and leg strength.

ETHICS

The study was reviewed and approved by the George Mason Institutional Review Board (reference number at IRBNET.com 1713399-1) and ClinicalTrials.gov (identifier NCT047096870). The study will also follow the proposed principles and guidance for ethical conduct in clinical trials established in the World Health Organization's Clinical Health Guidelines[70] and the World Medical Association Declaration of Helsinki.[71]

PATIENT SAFETY

Patient safety is a top priority. Prior to beginning training, subjects will be told to prioritize their personal safety above the interest of the study. The exercise training program is self-paced, and subjects may rest at any time during the activity. Participants may also stop the testing or the training at any time. The risk of slips, trips, and falls during assessment and training will be mitigated by allowing the subject to be within reach of a chair, counter, or wall during each session. Furthermore, training videos will offer seated alternatives to balance exercises if standing is too difficult. Research assistants will conduct weekly check-ins to address safety or other patient concerns.

DATA MANAGEMENT

All data collected will be securely stored on the REDCap platform. Data will be password-protected and only be accessible to the principal investigator and members of the research team. All REDCap data are stored on the secure server maintained by DSHI (the Center for Discovery Science and Health Informatics), which is HIPAA compliant. Information contained in the database spreadsheet will be identifiable only by a unique identification number. The identification number and data will be accessible only to members of the study team. Team members conducting virtual assessments and communication will ensure privacy by using a designated private room outside the line of sight others not on the research team and agreed upone by the participant. Subjects will select a private area of their residence.

LIMITATIONS

Due to the COVID-19 pandemic all assessments and the intervention will be online. It is important to note while these assessments were not originally validated for virtual administration, the research team developed the online surveys by closely following guidelines outlined by the International Society for Pharmacoeconomics and Outcomes

Research (ISPOR) task force for equivalence between electronic and paper-based patient-reported outcomes (PRO)[57] in attempt to emulate paper-based assessments. Furthermore, because the intervention videos are completed without the presence of a research assistant and at the ultimate discretion of each subject, specific parameters for exercise training may remain uncertain such as dosing, intensity, duration, and frequency.

DATA ANALYSIS

Statistics Statistical analysis will be completed using STATA IC version 15. For aim 1, comparison of means pre- and post-training will be performed using a paired t-test, if the data are normally distributed, with a significance level of $p \leq 0.05$ to determine if there was significant improvement in balance, physical activity, self-efficacy, and resilience. If the data are not normally distributed, a Wilcoxon signed rank test, will be used. Effect sizes will also be calculated. For aim 2, correlations will be used to determine the extent to which self-efficacy and resilience are associated with balance and physical activity before and after training.

Power and Sample Size Relevant data to accurately base the sample size on the primary outcome, balance, was not found in the literature. Sample size for a paired t-test was thereby determined using a calculation based on an effect size of 0.6. Accounting for a 10% anticipated drop-out rate, a sample size of 45 participants will be required to achieve a power of 80% and a level of significance of 5%, for detecting an effect size of 0.4 between pairs.

Evidence Summary Chart

Study	Sample	Intervention	Comparison	Outcome
Physical Activity and Functional Limitations in Older Adults: The Influence of Self-Efficacy and Functional Performance[50]	884 older adults	N/A	N/A	Findings provide further support for an efficacy-based model of functional limitations. Walking-related efficacy may help decrease or delay the onset of functional limitations.
Conceptions of Ability Affect Motor Learning[28]	58 college students	Participants in 3 groups practiced a balance task after receiving instructions that the task would be based upon an inherent ability (IA group), represent an acquirable skill (AS group), or no ability-related instructions (control group)	Inherent ability group v acquired skill group v control group	Learning was enhanced by instructions that portrayed the task as a learnable skill, rather than a fixed inherent capacity or no instructions (control group).
Altering Mindset Can Enhance Motor Learning in Older Adults[27]	older healthy adults ages 61-81	Balance task where 1 group received false feedback to enhance expectancy	Control v experimental group	Findings indicate that motor performance and learning in older age can be influenced quickly and positively by enhancing individuals' ability perceptions.

Enhanced Expectancies Improve Performance Under Pressure[44]	31 College Students	20 trials throwing accuracy task, then Enhanced-expectancy group participants were told that they were well-suited to perform under pressure, while the control group received neutral information, followed by 20 more trials	Enhanced expectancy v control	These findings provide evidence that enhancing individuals' expectancies regarding performance under pressure can affect their motor performance.
Lassoing Skill Through Learner Choice[40]	32 college students	Experiment 1: experimental group was given choice of the color of the mat; Experiment 2: compared the effectiveness of task-irrelevant (mat color)	Experiment 1: Choice group VS control; Experiment 2: task-relevant choice group VS task-irrelevant choice group	Learning effects are seen when learners are given choices; task-relevant and task-irrelevant choices resulted in similar learning benefits.
Physical Activity and Functional Limitations in Older Women: Influence of Self-Efficacy[29]	249 older women	N/A - prospective observational study	Baseline v follow-up	The findings suggest that physical activity, self-efficacy, and functional performance may all play a role in decreasing functional limitations. Both physical activity and self-efficacy represent important, modifiable factors that can enhance function.

Exercise self-efficacy in older adults: Social, affective, and behavioral influences[20]	174 older, formerly sedentary adults	walking and stretching/toning activity	walking v stretching & toning	Results suggest that self-efficacy levels change over the course of an exercise program and are influenced by affective, behavioral, and social factors
Self-efficacy Mediates the Relationship between Balance/Walking Performance, Activity, and Participation after Stroke[21]	59 stroke survivors	N/A - observational study	N/A	Results support the role of self-efficacy as a mediator between performance capacity, activity, and participation
Pathways from Physical Activity to Quality of Life in Older Women[53]	249 Older women	N/A - observational study	N/A	Results from this study support the use of self-efficacy in the relationship between physical activity and QOL.
Does the 'Otago exercise programme' reduce mortality and falls in older adults?: a systematic	Meta-analysis on community-dwelling older adults 65 and older	Otago intervention	N/A	Systematic review found that the program was effective in significantly reducing the rate of falls in community-dwelling older adults

review and meta-analysis[19]				

Executive Summary

Balance and Physical Activity

Balance is defined as "the ability to stay upright and steady when stationary and during movement".[7] The literature suggests that balance impairment can be ameliorated through exercise programs in healthy community-dwelling adults and older adults.[7,16,17] For example, the widely prescribed Otago exercise program includes a progression of strength and balance exercises with increasing ankle weights and repetitions in conjunction with a walking plan.[18] A systematic review found that the program was effective in significantly reducing the rate of falls in community-dwelling older adults.[19] Interestingly, another systematic review on exercise for balance training for older adults concluded that exercises that challenge balance at a high dosage and do not include a walking program.[6] Finally, a third systematic review on balance training in older adults concluded that programs involving gait, balance, coordination, functional exercises, and strengthening exercises improve balance in certain indirect measures including the single leg stance. It was also noted that this evidence is not robust, as there are large amounts of missing data throughout the included studies.[7]

Self-Efficacy, Balance, and Physical Activity

Self-efficacy can be summarized as, "belief in one's capabilities to organize and execute the courses of action required to produce given attainments".[25] As explained by Bandura, an individual with low self-efficacy is less likely to exert optimal effort towards a task (e.g., exercise and physical activity) or persist in the face of difficulties,[26] especially if they are already struggling with obstacles to successful performance such as moving with a balance impairment. Several studies suggest balance interventions grounded in promotion of self-efficacy are more effective than those not grounded in promotion of self-efficacy.[27,28,29] Interestingly, self-efficacy has been reported as the most important variable in predicting physical activity behaviors,[20,30] and also a significant predictor of balance performance in the stroke population.[21]

Resilience and Physical Activity

Resilience has been proposed as another contributing factor to successful aging and quality of life.[31,32] Resilience describes a person's physical and psychological ability to recover and thrive in the face of adversity. In relation to the benefits of physical activity, physical fitness appears to have a buffer effect against the body's hormonal response to stress, contributing to reduced emotional and physiological reactivity as well as increased positive mood and well-being.[33] Physical fitness has been defined as, "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies"[34]. Furthermore, challenging physical activities have been shown to promote resilience by increasing confidence and mental toughness.[35] Resilience has been found to improve after a rehabilitation program in the stroke population,[36] thus indicating it can be a target modifiable factor in rehabilitation, yet has not been well studied outside of clinical populations.

Balance, Physical Activity, Self-Efficacy and Resilience

Existing evidence supports the use of movement training programs to improve balance in older adults.[5–7,16,17] Participation in physical activity provides more opportunity to improve balance through motor learning,[48] resulting in increased self-efficacy if successful.[48] Additionally, individuals with high self-efficacy are more likely to participate in physical activity[22,29,49,50] and have better balance.[10,11,21,28,48] Furthermore, individuals with better balance are more likely to engage in physical activity.[51] Ultimately, balance impairment may contribute to decreased SE and resilience, loss of independence, and poor quality of life.[52–54] Also, challenging physical activity has been shown to increase resilience.[35]

Documents

Confidential

Informed Consent

Please complete the survey below.

Thank you!

Outcomes of Powerbraining

INFORMED CONSENT FORM

INVESTIGATORS

Role

Name/Degree

Department

PRINCIPAL INVESTIGATOR

Andrew A. Guccione, PT, PhD, DPT, FAPTA

Rehabilitation Science

CO-INVESTIGATOR

Julie Ries, PT, PhD

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RESEARCH ASSISTANT

Lobna Elsarafy

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Randy J. Pugh

Rehabilitation Science

SUPPORTED BY
This research is supported by George Mason University

KEY INFORMATION
The purpose of this study is to investigate the outcomes of a 24 session on-line mobility and cognitive exercise program for community-based adults and older adults. The primary outcomes of interest are changes in cognitive functioning and mobility, with secondary outcomes related to self-efficacy, resilience, and physical activity. You have been asked to participate because you meet the study rationale of the targeted population. You may want to participate because you are interested in the contributing research. Reasons not to participate are time commitment, lack of interest in this study, lack of internet access with video and audio capability or severe underlying health-conditions preventing exercise.

RESEARCH PROCEDURES
This research is being conducted to understand the outcomes of a 24 session on-line mobility and cognitive exercise program for community-based adults and older adults. The primary outcomes of interest are changes in cognitive functioning and mobility, with secondary outcomes related to self-efficacy, resilience, and physical activity. If you agree to participate, you will be asked to participate in 24 online training sessions following a virtual initial assessment of your health history, readiness for physical activity, balance confidence. Training sessions will occur three times per week for eight to twelve weeks. At the conclusion of training, you will be asked to repeat your initial assessment.

We expect that you will be in this research study for 18 hours total including pre- and post- testing and 24 sessions of training over 8-12 weeks.

You may be asked to complete the following online surveys and assessments as part of the pre- and post- training evaluations:

• Questionnaires & Surveys – you may be asked to complete on-line health-related questionnaires and surveys that measure self-efficacy, resilience, and balance confidence.
• Cognitive Assessment- you may be asked to complete online assessments with a member of the research team via videoconference that measure attention, working memory, and response time,
• Muscle strength and balance assessment– you may be asked to perform repetitive functional movements and static balance with virtual observation from a member of the research team.

Each evaluation session will last approximately 120 minutes (two hours) and be held on the same day. The total time commitment for both evaluations will be approximately 240 minutes (4 hours). The order of evaluation sessions will be

Training Procedures

Training sessions are performed three times per week for 8 weeks. Training will occur virtually by logging onto the Powerbraining website and completing the assigned pre-recorded video. Powerbraining is a virtual exercise platform with various live and pre-recorded exercise classes. The Brain and Balance class is selected for this study. This program is a collection of exercises designed to improve mobility, balance and cognition. The program requires following an avatar trainer while simultaneously problem solving and performing various exercises. Each training session will last approximately 35 minutes, three times per week for 8 weeks. A member of the research team will reach out weekly with email and or phone call to answer questions and discuss concerns regarding training.

Videography and photography

Video and photographs may be included when disseminating research presentations at conferences and in teaching presentations. You have the right to decline videotaping and/or photography at any session or any given point while videotaping. Your videos may be used for training and teaching purposes. To the extent possible, you will be recorded in ways that will diminish facial recognition. Video material (photos and videos) will remain on a secure hard drive and deleted after five years following the study's completion. While participating in the study or after your participation has ended, you may request the immediate removal of your videotapes and photos from storage. Some tests may be recorded before and after training.
While it is understood that no computer transmission can be perfectly secure, reasonable efforts will be made to protect the confidentiality of your transmission. Participants may review Zoom for information about their privacy statement by visiting: https://zoom.us/privacy.

Re-testing Procedures

At the conclusion of 24 sessions, you will be retested with the same assessments as baseline testing.

Time Commitments

Participants will need to be available for approximately 2 hours of testing prior to and following training for approximately 4 total hours of testing and a total of 24 training sessions (three 35-minute sessions per week for 8 weeks). The total time commitment will be approximately 18 hours.

There is no probability of random assignment, as all eligible participants who agree to participate will receive the same treatment.

RISKS

The foreseeable risks or discomforts of study participation are similar to the risks that you take when exercising or engaging in moderate vigorous physical activity on your own, with or without supervision, at home or in a gym or other facility. For this testing and training, you will not be asked to engage in any activity that you believe is beyond your ability or tolerance.

You may experience discomfort from training sessions, including muscle fatigue, muscle or joint soreness, and lightheadedness during or in the hours following testing or training. The occurrence of a muscle strain or similar minor musculoskeletal injury is a small possibility during testing or training. Straining a muscle or spraining a ligament is a minimal possibility during training. Muscle soreness is generally mild and is expected to subside. Subsequent exercise of the affected muscle group does not increase the severity of this symptom and there are no long-term effects of its presence.

The risks of testing and training are generally low, although sometimes medical complications, including heart attack and sudden death, do occur. Although rare in occurrence the most serious risks of testing and training include dizziness, chest pain or tingling in the arm, jaw, or back, shortness of breath, and/or extreme fatigue. Please let the research team know if you experience any of these symptoms during testing or training activities at rhbstudy@gmu.edu.

During exercise and moderate physical activity, certain changes in heart rate and rhythm, blood pressure, and respiratory rate are expected, but abnormal or unanticipated changes are small possibilities. You will be able to pace yourself throughout the training and may adapt an exercise to your own level of tolerance as you see fit.
There is a small risk a fall, slip, or trip during assessment and training. Every effort will be made to minimize these risks using a chair, counter, or wall for during the exercise.

If you experience any symptoms, difficulties or safety concerns, please contact the research team immediately at rhbstudy@gmu.edu.

In case of life-threatening injury during training, please stop immediately and call 911. Neither George Mason University nor the investigators have funds available for medical treatment payment for injuries that you may sustain while participating in this research. Should you need medical care, you or your insurance carrier will be responsible for payment of the expenses required for medical treatment.

In case of injury during testing procedures, the GMU research team will not be able to provide basic first aid. If appropriate, the staff will call the emergency response team at 911. Neither GMU nor the investigators have funds available for payment of medical treatment for injuries that you may sustain while participating in this research. Should you need medical care, you or your insurance carrier will be responsible for payment of the expenses required for medical treatment.

BENEFITS

Although there is evidence to suggest that there are some health benefits to exercise, there is no guarantee that participants will receive such benefits. Participants who complete study including all 24 training sessions, will receive a complimentary 1-year membership to Powerbraining, a value of $156.00. Participants who do not complete the study as described will be ineligible for the complimentary 1-year membership.

CONFIDENTIALITY

The data in this study will be confidential, including in publications and reports resulting from the research. All participants will be assigned a de-identified number after agreeing to participate, and all de-identified data will be stored using this identification number. The signed informed consent and the identification number linking data to individuals will be stored by the lead researcher in a locked cabinet in a locked office along with any other forms or papers that have protected personal or health information. Only members of the research team will have access to this information. The de-identified data could be used for future research without additional consent from participants. Monitors, auditors, the Institutional Review Board, and regulatory authorities may have access to the data for verification of clinical trial procedures without violating the confidentiality of the participants to the extent permitted by law.

De-identified data may be used for future research without requiring additional consent.

The Institutional Review Board (IRB) committee that monitors research on human subjects may inspect study records during internal auditing procedures and are required to keep all information confidential.

Monitors, auditors, the US Office of Research Integrity (ORI), the US Office for the Protection of Human Research Protections (OHRP), and the US Food and Drug Administration (FDA) may also be granted direct access to your study records to oversee the research. By signing this consent document, you are authorizing their access.

PARTICIPATION

Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.
Clinically relevant research results, including individual research results, will be disclosed to subjects upon request, at the conclusion of the study.
Significant new findings developed during the research, which may relate to your willingness to continue will be provided to you.

The anticipated circumstances under which your participation may be terminated by the investigator without regard to your consent include a belief by the research team that continued testing or training may affect your health or safety; you are unable to follow or adhere to testing or training instructions; or other administrative reasons that require your withdrawal.

Procedures for orderly termination of participation include speaking with a member of the research team and submitting your request in writing to rhbstudy@gmu.edu.

ALTERNATIVES TO PARTICIPATION

There are no alternatives to participation for this study.

CONTACT

This research being conducted is led by Dr. Andrew Guccione, Department of Rehabilitation Science, at George Mason University. He may be reached at aguccion@gmu.edu for questions or to report a research-related problem. You may contact the George Mason University Institutional Review Board Office at 703-993-4121 if you have questions or comments regarding your rights as a participant in the research.

This research has been reviewed according to George Mason University procedures governing your participation in this research, IRBnet #:1713399-1.

CONSENT

1) Your signature documents your permission to take part in this research. You will be provided a copy of this signed document.
Please indicate below your preference for videography/photography. This will not affect your participation in the study.

◯ I grant permission to videotape my image and likeness as part of this research study.
◯ I DO NOT grant permission to videotape my image and likeness as part of this research study.

2) Signature of Participant

____

3) Date

____

4) Participant First Name

____

5) Participant Last Name

____

6) Signature of Person Obtaining Consent

____

7) Date

____

8) Name of Person Obtaining Consent

____

Screening Tool

Please complete the survey below.

Thank you!

Introduce Yourself

"Hello, my name is _____________ from the department of Rehabilitation Science at George Mason University."

Tell them why you are calling and the purpose of the study.

"We are working on a research study to evaluate the impact of The BRAINing™ Center's "Brain & Balance" training program mobility, balance, cognition and psychological well-being in generally healthy older adults.

If you're interested in learning more, can I request your permission to ask questions to see if you qualify for this research study? The screening responses of those ineligible or who choose not to participate will neither be saved nor used in the research. "

○ Yes ○ No

If no -- thank them for their time and politely end call.
If yes -- continue below.

"We will be collecting information about you during this call. Your part on this call is completely voluntary. The information collected will only be seen by researchers on this study team. We make sure the information is kept private and is only used for this particular research study. If you do not want to continue the phone call, it will not affect any aspect of your relationship with George Mason University or you living facility."

○ Yes ○ No

If no -- thank them for their time and politely end call.
If yes -- continue below.

"To see if you are eligible for this study, is it alright if I ask you a few questions?"

○ Yes ○ No

"Are you 55 to 80 years of age?"

○ Yes ○ No

"Do you have any problems or health issues that may limit your ability to understand legal documents or multistep instructions?"

○ Yes ○ No

"Have you been diagnosed with a heart, blood, lung, vascular or metabolic condition that is not controlled by medication or a doctor's care?"

○ Yes ○ No

"Are you able to take at least 4 steps without an assistive device like a cane or a walker?"

○ Yes ○ No

"Do you have access to the internet and a computer (or tablet with connected keyboard)"?

◯ Yes ◯ No

Subject DOES meet eligibility criteria up to this point.

◯ True ◯ False

Subject DOES NOT meet eligibility criteria up to this point.

If potential subject does not meet criteria, thank them for their time and politely end the call.

If potential subject meets criteria at this point, continue on.

"The research study consists of an 8-week online mobility and cognitive exercise program, with 30-minute sessions three times a week. This program is a collection of exercises designed to improve mobility, balance and cognition. The program requires following an avatar trainer while simultaneously problem solving and performing various exercises.

Additionally, there will be 2 hour virtual assessment and evaluation sessions before and after the 8-week exercise program. Evaluations will include surveys, cognitive testing, and balance testing all performed online."

"Do you have any additional questions for me?"

Email address:

____
((read back to subject))

Phone number:

____
((verify best phone number))

Physical Activity Readiness Questionnaire

Please complete the survey below.

Thank you!

2017 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.

1) Has your doctor ever said that you have a heart condition?	◯ Yes ◯ No
OR has your doctor ever said that you have high blood pressure?	◯ Yes ◯ No
2) Do you feel pain in your chest at rest, during your daily activities of living, OR when you do physical activity?	◯ Yes ◯ No
3) Do you lose balance because of dizziness OR have you lost consciousness in the last 12 months? Please answer NO if your dizziness was associated with over-breathing (including during vigorous exercise).	◯ Yes ◯ No
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?	◯ Yes ◯ No
PLEASE LIST CONDITION(S) HERE:	
5) Are you currently taking prescribed medications for a chronic medical condition?	◯ Yes ◯ No
PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:	

6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer NO if you had a problem in the past, but itdoes not limit your current abilityto be physically active.	◯ Yes ◯ No
PLEASE LIST CONDITION(S) HERE:	
7) Has your doctor ever said that you should only do medically supervised physical activity?	◯ Yes ◯ No

If you answered NO to all of the questions above, you are cleared for physical activity. You will be taken to the end of this survey to sign the PARTICIPANT DECLARATION.

Start becoming much more physically active – start slowly and build up gradually.Follow International Physical Activity Guidelines for your age (www.who.int/dietphysicalactivity/en/).You may take part in a health and fitness appraisal.If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.If you have any further questions, contact a qualified exercise professional.

If you answered YES to one or more of the questions above, COMPLETE THE NEXT SECTION.

Delay becoming more active if:

You have a temporary illness such as a cold or fever; it is best to wait until you feel better.You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.Your health changes - answer the questions below and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

2017 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. Do you have Arthritis, Osteoporosis, or Back Problems?	◯ Yes ◯ No
1a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
1b. Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	◯ Yes ◯ No

1c. Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	◯ Yes ◯ No
2. Do you currently have Cancer of any kind?	◯ Yes ◯ No
2a. Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	◯ Yes ◯ No
2b. Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	◯ Yes ◯ No
3. Do you have a Heart or Cardiovascular Condition? (This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm.)	◯ Yes ◯ No
3a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
3b. Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	◯ Yes ◯ No
3c. Do you have chronic heart failure?	◯ Yes ◯ No
3d. Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	◯ Yes ◯ No
4. Do you have High Blood Pressure?	◯ Yes ◯ No
4a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
4b. Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer YES if you do not know your resting blood pressure)	◯ Yes ◯ No
5. Do you have any Metabolic Conditions? (This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes.)	◯ Yes ◯ No
5a. Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician prescribed therapies?	◯ Yes ◯ No

5b. Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	◯ Yes ◯ No
5c. Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, OR the sensation in your toes and feet?	◯ Yes ◯ No
5d. Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	◯ Yes ◯ No
5e. Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	◯ Yes ◯ No
6. Do you have any Mental Health Problems or Learning Difficulties? (This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome.)	◯ Yes ◯ No
6a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
6b. Do you have Down Syndrome AND back problems affecting nerves or muscles?	◯ Yes ◯ No
7. Do you have a Respiratory Disease? (This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure.)	◯ Yes ◯ No
7a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
7b. Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	◯ Yes ◯ No
7c. If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	◯ Yes ◯ No
7d. Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	◯ Yes ◯ No

8. Do you have a Spinal Cord Injury? (This includes Tetraplegia and Paraplegia.)	◯ Yes ◯ No
8a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
8b. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	◯ Yes ◯ No
8c. Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	◯ Yes ◯ No
9. Have you had a Stroke? (This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event.)	◯ Yes ◯ No
9a. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments)	◯ Yes ◯ No
9b. Do you have any impairment in walking or mobility?	◯ Yes ◯ No
9c. Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	◯ Yes ◯ No
10. Do you have any other medical condition not listed above or do you have two or more medical conditions?	◯ Yes ◯ No
10a. Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months OR have you had a diagnosed concussion within the last 12 months?	◯ Yes ◯ No
10b. Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	◯ Yes ◯ No
10c. Do you currently live with two or more medical conditions?	◯ Yes ◯ No
PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE:	________________________________
Continue for recommendations about your current medical condition(s).	

If you answered NO to all of the follow-up questions about your medical condition,You are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs. You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises. As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week. If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.

If you answered YES to one or more of the follow-up questions about your medical condition:

You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the ePARmed-X+ at www.eparmedx.com and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

Delay becoming more active if:

You have a temporary illness such as a cold or fever; it is best to wait until you feel better. You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active. Your health changes - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

You must use the entire questionnaire and NO changes are permitted. The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

Warburton, D. E., Jamnik, V. K., Bredin, S. S. D., Shephard, R. J., & Gledhill, N. (2017). The 2017 Physical Activity

Readiness Questionnaire for Everyone (PAR-Q+) and electronic Physical Activity Readiness Medical Examination (ePARmed-)

Demographics

Please complete the survey below.

Thank you!

Participant Information

First name	__________________________
Last name	__________________________
Email address	__________________________
Phone number	__________________________
Date of Birth	__________________________
Age	__________________________
Sex	◯ Male ◯ Female
Race (check all that apply)	☐ American Indian/Alaska Native ☐ Native Hawaiian or Other Pacific Islander ☐ Black or African American ☐ Asian ☐ White (including Middle Eastern) ☐ Other ☐ Decline

Ethnicity

◯ 1) Hispanic or Latino
◯ 2) Not Hispanic or Latino

Education (Please check one)

◯ 1) Less than high school
◯ 2) Some high school
◯ 3) High school graduate
◯ 4) Attended or graduated from technical school
◯ 5) Attended college, did not graduate
◯ 6) College graduate
◯ 7) Completed graduate school/advanced degree

Employment/Work (Check all that apply)

☐ 1) Working full-time outside of home
☐ 2) Working part-time outside of home
☐ 3) Working full-time from home
☐ 4) Working part-time from home
☐ 5) Working with modification in job because of current illness/injury
☐ 6) Not working because of current illness/injury
☐ 7) Homemaker
☐ 8) Student
☐ 9) Retired
☐ 10) Unemployed

Do you use a: (Check all that apply)

☐ 1) Cane?
☐ 2) Walker, rolling walker, or rollator?
☐ 3) Manual wheelchair?
☐ 4) Motorized wheelchair?
☐ 5) Other:
☐ 6) None

Other: ______________________________

With whom do you live? (Check all that apply)

☐ 1) Alone
☐ 2) Spouse/significant other
☐ 3) Child/children
☐ 4) Other relative(s)
☐ 5) Group setting
☐ 6) Personal care attendant
☐ 7) Other:

Other: ______________________________

Where do you live?

○ 1) Private home
○ 2) Private home with at-home community benefits
○ 2) Private apartment
○ 3) Rented room
○ 4) Board and care/assisted living/group home
○ 5) Homeless (with or without shelter)
○ 6) Long-term care facility (nursing home)
○ 7) Hospice
○ 8) Other

Study Start Information

Date participant signed consent	______________________
First session	______________________
Final session	______________________

Optimal Instrument

Please complete the survey below.

Thank you!

OPTIMAL Instrument

Confidence

Instructions: Please select the level of confidence you have for doing each activity today

	Fully confident in my ability to perform	Very confident	Moderate confidence	Some confidence	Not confident in my ability to perform	Not applicable
1. Lying flat	○	○	○	○	○	○
2. Rolling over	○	○	○	○	○	○
3. Moving - lying to sitting	○	○	○	○	○	○
4. Sitting	○	○	○	○	○	○
5. Squatting	○	○	○	○	○	○
6. Bending/stooping	○	○	○	○	○	○
7. Balancing	○	○	○	○	○	○
8. Kneeling	○	○	○	○	○	○
9. Standing	○	○	○	○	○	○
10. Walking - short distance	○	○	○	○	○	○
11. Walking - long distance	○	○	○	○	○	○
12. Walking - outdoors	○	○	○	○	○	○
13. Climbing stairs	○	○	○	○	○	○
14. Hopping	○	○	○	○	○	○
15. Jumping	○	○	○	○	○	○
16. Running	○	○	○	○	○	○
17. Pushing	○	○	○	○	○	○
18. Pulling	○	○	○	○	○	○
19. Reaching	○	○	○	○	○	○
20. Grasping	○	○	○	○	○	○
21. Lifting	○	○	○	○	○	○
22. Carrying	○	○	○	○	○	○

Optimal Score ________________________

International Physical Activity Questionnaire Long

Please complete the survey below.

Thank you!

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. Think about all the vigorous and moderate activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?	◯ Yes ◯ No > Skip to PART 2: TRANSPORTATION

The next questions are about all the physical activity you did in the last 7 days as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work? Think about only those physical activities that you did for at least 10 minutes at a time.	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No vigorous job-related physical activity > Skip to question 4

3. How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?

hours per day	______________________
minutes per day	______________________
4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads as part of your work? Please do not include walking.	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No moderate job-related physical activity > Skip to question 6

5. How much time did you usually spend on one of those days doing moderate physical activities as part of your work?

hours per day ________________________

minutes per day ________________________

6. During the last 7 days, on how many days did you walk for at least 10 minutes at a time as part of your work? Please do not count any walking you did to travel to or from work.

◯ 1 day per week
◯ 2 days per week
◯ 3 days per week
◯ 4 days per week
◯ 5 days per week
◯ 6 days per week
◯ 7 days per week
◯ No job-related walking > Skip to PART 2: TRANSPORTATION

7. How much time did you usually spend on one of those days walking as part of your work?

hours per day ________________________

minutes per day ________________________

PART 2: TRANSPORTATION PHYSICAL ACTIVITY These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the last 7 days, on how many days did you travel in a motor vehicle like a train, bus, car or tram?

◯ 1 day per week
◯ 2 days per week
◯ 3 days per week
◯ 4 days per week
◯ 5 days per week
◯ 6 days per week
◯ 7 days per week
◯ No traveling in a motor vehicle > Skip to question 10

9. How much time did you usually spend on one of those days traveling in a train, bus, car, tram, or other kind of motor vehicle?

hours per day ________________________

minutes per day ________________________

Now think only about the bicycling and walking you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the last 7 days, on how many days did you bicycle for at least 10 minutes at a time to go from place to place?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No bicycling from place to place > Skip to question 12
11. How much time did you usually spend on one of those days to bicycle from place to place?	
hours per day	______________________________
minutes per day	______________________________
12. During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No walking from place to place > Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR
13. How much time did you usually spend on one of those days walking from place to place?	
hours per day	______________________________
minutes per day	______________________________

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY This section is about some of the physical activities you might have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, chopping wood, shoveling snow, or digging in the garden or yard?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No vigorous activity in garden or yard > Skip to question 16
15. How much time did you usually spend on one of those days doing vigorous physical activities in the garden or yard?	
hours per day	______________________________

minutes per day	__________________________________
16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, sweeping, washing windows, and raking in the garden or yard?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No moderate activity in garden or yard > Skip to question 18
17. How much time did you usually spend on one of those days doing moderate physical activities in the garden or yard?	
hours per day	__________________________________
minutes per day	__________________________________
18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, washing windows, scrubbing floors and sweeping inside your home?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No moderate activity inside home > Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY
19. How much time did you usually spend on one of those days doing moderate physical activities inside your home?	
hours per day	__________________________________
minutes per day	__________________________________

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY This section is about all the physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No walking in leisure time > Skip to question 22
21. How much time did you usually spend on one of those days walking in your leisure time?	

hours per day __________________________________

minutes per day __________________________________

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time?

- ◯ 1 day per week
- ◯ 2 days per week
- ◯ 3 days per week
- ◯ 4 days per week
- ◯ 5 days per week
- ◯ 6 days per week
- ◯ 7 days per week
- ◯ No vigorous activity in leisure time > Skip to question 24

23. How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time?

hours per day __________________________________

minutes per day __________________________________

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your leisure time?

- ◯ 1 day per week
- ◯ 2 days per week
- ◯ 3 days per week
- ◯ 4 days per week
- ◯ 5 days per week
- ◯ 6 days per week
- ◯ 7 days per week
- ◯ No moderate activity in leisure time > Skip to PART 5: TIME SPENT SITTING

25. How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?

hours per day __________________________________

minutes per day __________________________________

PART 5: TIME SPENT SITTING The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the last 7 days, how much time did you usually spend sitting on a weekday?

hours per day __________________________________

minutes per day __________________________________

hours per day	__________________________________
minutes per day	__________________________________
22. Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No vigorous activity in leisure time > Skip to question 24
23. How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time?	
hours per day	__________________________________
minutes per day	__________________________________
24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your leisure time?	◯ 1 day per week ◯ 2 days per week ◯ 3 days per week ◯ 4 days per week ◯ 5 days per week ◯ 6 days per week ◯ 7 days per week ◯ No moderate activity in leisure time > Skip to PART 5: TIME SPENT SITTING
25. How much time did you usually spend on one of those days doing moderate physical activities in your leisure time?	
hours per day	__________________________________
minutes per day	__________________________________

PART 5: TIME SPENT SITTING The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the last 7 days, how much time did you usually spend sitting on a weekday?	
hours per day	__________________________________
minutes per day	__________________________________

27. During the last 7 days, how much time did you usually spend sitting on a weekend day?

hours per day ______________________________

minutes per day ______________________________

This is the end of the questionnaire, thank you for participating.

This physical activity questionnaire is publically available, it is open access, and no permissions are required to use

it. So we encourage any researchers to use it where it will be an appropriate measure of physical activity, particularly in larg
https://sites.google.com/site/theipaq/

Activities-Specific Balance Confidence (ABC) Scale

Please complete the survey below.

Thank you!

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

No confidence --- Completely Confident

---

1) 1. Walk around the house? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

2) 2. Walk up or down stairs? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

3) 3. Bend over and pick up a slipper(or item)from the front of a closet floor _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

4) 4. Reach for a small can off a shelf at eye level? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

5) 5. Stand on your tiptoes and reach for something above your head? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

6) 6. Stand on a chair and reach for something? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

7) 7. Sweep the floor? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

8) 8. Walk outside the house to a car parked in the driveway? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

9) 9. Get into or out of a car? _____%

No confidence 0% — Completely confident 100%

(Place a mark on the scale above)

10) 10. Walk across a parking lot to the mall (store)? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

11) 11. Walk up or down a ramp? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

12) 12. Walk in a crowded mall where people rapidly walk past you? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

13) 13. Are bumped into by people as you walk through the mall? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

14) 14. Step onto or off an escalator while you are holding onto a railing? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

15) 15. Step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

16) 16. Walk outside on icy sidewalks? ____%
No confidence 0% — Completely confident 100%
(Place a mark on the scale above)

17) Survey date ______________________________

18) Score ______________________________

Connor-Davidson Resilience Scale 25 (CD-RISC-25)

Please complete the survey below.

Thank you!

For each item, please mark an "x" in the box below that best indicates how much you agree with the following statements as they apply to you over the last month. If a particular situation has not occurred recently, answer according to how you think you would have felt.

		not true at all (0)	rarely true (1)	sometimes true (2)	often true (3)	true nearly all the time (4)
1)	1. I am able to adapt when changes occur.	○	○	○	○	○
2)	2. I have at least one close and secure relationship that helps me when I am stressed.	○	○	○	○	○
3)	3. When there are no clear solutions to my problems, sometimes fate or God can help.	○	○	○	○	○
4)	4. I can deal with whatever comes my way.	○	○	○	○	○
5)	5. Past successes give me confidence in dealing with new challenges and difficulties.	○	○	○	○	○
6)	6. I try to see the humorous side of things when I am faced with problems.	○	○	○	○	○
7)	7. Having to cope with stress can make me stronger.	○	○	○	○	○
8)	8. I tend to bounce back after illness, injury, or other hardships.	○	○	○	○	○
9)	9. Good or bad, I believe that most things happen for a reason.	○	○	○	○	○
10)	10. I give my best effort no matter what the outcome may be.	○	○	○	○	○
11)	11. I believe I can achieve my goals, even if there are obstacles.	○	○	○	○	○
12)	12. Even when things look hopeless, I don't give up.	○	○	○	○	○
13)	13. During times of stress/crisis, I know where to turn for help.	○	○	○	○	○
14)	14. Under pressure, I stay focused and think clearly.	○	○	○	○	○
15)						

	15. I prefer to take the lead in solving problems rather than letting others make all the decisions.	○	○	○	○	○
16)	16. I am not easily discouraged by failure.	○	○	○	○	○
17)	17. I think of myself as a strong person when dealing with life's challenges and difficulties.	○	○	○	○	○
18)	18. I can make unpopular or difficult decisions that affect other people, if it is necessary.	○	○	○	○	○
19)	19. I am able to handle unpleasant or painful feelings like sadness, fear, and anger.	○	○	○	○	○
20)	20. In dealing with life's problems, sometimes you have to act on a hunch without knowing why.	○	○	○	○	○
21)	21. I have a strong sense of purpose in life.	○	○	○	○	○
22)	22. I feel in control of my life.	○	○	○	○	○
23)	23. I like challenges.	○	○	○	○	○
24)	24. I work to attain my goals no matter what roadblocks I encounter along the way.	○	○	○	○	○
25)	25. I take pride in my achievements.	○	○	○	○	○

4-Stage Balance Test

Please complete the survey below.

Thank you!

Instructions to the patient:

I'm going to show you four positions.

For the first 3 positions, try to stand in each position for 10 seconds. For the last position, you will try to hold it for 30 seconds

You can hold your arms out, or move your body to help keep your balance, but don't move your feet. For each position I will say, "Ready, begin." Then, I will start timing. After 10 seconds, I will say, "Stop."

---

1. Stand with your feet side-by-side.

---

1) Time: ______ seconds ______________________________

2) Comments: ______________________________

---

2. Place the instep of one foot so it is touching the big toe of the other foot.

---

3) Time: ______ seconds ______________________________

4) Front foot
   ◯ left
   ◯ right

5) Comments: ______________________________

---

3. Tandem stand: Place one foot in front of the other, heel touching toe.

---

6) Time: ______ seconds ______________________________

7) Front foot
   ◯ left
   ◯ right

8) Comments: ______________________________

---

4. Stand on one foot. (*hold for 30 secs)

---

9) Time: ______ seconds ______________________________

10) Foot
   ◯ left
   ◯ right

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