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The Efficacy of Handheld Resistive Exercise Device (HRED) Training on Wellness Outcome in Older Adults

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ABSTRACT

International Journal of Exercise Science 10(8): 1208-1225, 2017. The primary purpose of this study was to examine the efficacy of Handheld Resistive Exercise Device (HRED) training on wellness outcomes in older adults. A secondary purpose was to assess the utilization of an HRED in older adult fitness program. A group of healthy, active older adults (N=28, 76.6 ± 6.7 years old) volunteered to complete a 10-week HRED training program. Pre- and post-intervention changes were evaluated for muscular strength, static balance, mobility, fall-efficacy, and self-efficacy for activities of daily living. Significant improvement was seen in muscular strength (grip strength, $p < 0.01$), mobility (TUG time, $p < 0.01$), and self-efficacy for jogging ($p = 0.036$) and push-ups ($p = 0.045$). Most of participants (92.9%) indicated that they would like to continue exercising with the HRED. A 10-week HRED exercise program produced some improvement on wellness outcomes in older adults and the HRED is an acceptable fitness device for this population.

KEY WORDS: Resistive exercise, older adults, muscular strength, fall efficacy

INTRODUCTION

Older adults represent the fastest growing and largest demographic in the United States in the next decade (53). Trends suggest that this population will represent 20% of the population in the United States by 2030 and double in size by 2050 (37). The shifting demographics and increased longevity has fueled interest in factors that influence quality of life (QOL) as adults age. Increased longevity often brings with it changes to mobility and increased risk for incidences of isolation and depression, reduction in quality of life, and a reduced capacity for performing activities of daily living (ADL) (21). The nature of these changes is greatly influenced by behavior choices prior to and during older adulthood.

Engaging in a physically active lifestyle can mitigate quality of life declines associated with aging (11, 20, 52). Regular physical activity during adulthood is associated with improved stress management, sleep patterns, and global quality of life (6, 14). Unfortunately, older adults are among the most sedentary population (33). Data suggests that fewer than 1 in 3 older adults engage regularly in physical activity (15) and the level of physical inactivity (e.g. no leisure time physical activity) increases with age (14). Women are particularly at risk for age-related declines in physical activity and less likely to engage in and persist with exercise programming (49). The American College of Sport Medicine (ACSM) recommends older adults engage in regular physical activity consisting of 150 minutes of moderate-to-vigorous physical activity (MVPA) per week, with an additional 2-3 days of resistance and flexibility exercises, and 2 or more days of functional fitness training (25). Nationally, only 11% of older adults meet the recommendations for muscular strengthening and fewer than half meet the recommendations for aerobic physical activity (15). An abundance of research has explored the constraints to regular exercise demonstrating that individual, environmental, and task constraints can influence exercise patterns in older adults.

Individuals' self-perception of poor health is the most commonly reported barrier to exercise in older adults (17). Similarly, self-efficacy, one's self-perception of the ability to accomplish a behavior (8), is associated with exercise engagement and persistence (31). Individuals with higher levels of self-efficacy for exercise are more likely to begin and persist with exercise programs (50) and identify more facilitators for exercise, including "enjoyment" (55). Environments that provide social support for physical activity have been shown to enhance enjoyment for exercise and psychological well-being in older adults (16). Community-based exercise programming for older adults capitalizes on a shared environment to foster social support while targeting health and wellness attributes.

Several recent studies have explored the efficacy of community-based exercise programs for enhancing health and wellness in older adults. Traditional strength training programs have demonstrated success in increasing muscle strength (47), improving self-efficacy for movement (41), reducing fall risk (46), and improving biomarkers for health (2), however, they have struggled to appeal to large segments of the population or create sustained behavior change in older adult populations (38). The exact factors that limit engagement and persistence in strength training in older adults remains unclear. Research suggest older adults perceive traditional strength training as time consuming, requiring heavy resistance and complex movement patterns, and as raising the potential for injury (54).

Non-traditional strength training programs appear to be gaining in popularity in older adult populations (18, 19, 24, 30). Recently programs have been developed to promote muscular strength, functional training programs have also been shown to enhance older adults' ability to perform ADLs (19). In one example, Crandall and colleagues demonstrated improved functional performance in older adults following a 10-week multicomponent exercise program featuring *Bingocize*™ (18). Participants noted the novelty of the exercise and the social support of the group exercise format as motivators for participation.

The primary purpose of this study was to examine the efficacy of HRED training on wellness outcomes (e.g., blood pressure, body mass index, fall-efficacy, and self-efficacy for activities of daily living) in older adults. It was hypothesized that a 10-week HRED exercise program would result in positive changes in wellness-related outcomes. A secondary purpose was to assess the utilization of an HRED in older adult fitness programming, with particular attention to its utility in promoting adherence to a regular fitness routine.

METHODS

Participants

Thirty-four older adults (age > 60 years) who live or exercise at a retirement community in the southwestern United States volunteered to participate in this study. Participants were recruited through posted flyers in the retirement community's Aquatic & Fitness Center and through a snowball approach, which has been found to be particularly useful in older adult recruitment. A review of previous research and an *a priori* power analysis suggested a sample size greater than 26. Additional subjects were recruited to account for attrition. To be eligible, participants needed to be independent living residents with no history of recent major medical conditions, and able to stand continuously for at least 30-minutes. Individuals with a history of heart disease, joint or orthopedic concerns, asthma, diagnosed cognitive impairment, or recent surgery were excluded. Twenty-eight volunteers met the inclusion criteria (mean age 76.6 ± 6.7 years, 21 women and 7 men). All participants were self-described as "physically active" and had participated in a community-based physical activity program in the past year. Half the participants were classified as overweight (n=9, 32.1%) or obese (n=5, 17.9%) using body mass index (mean BMI 26.06 ± 4.36 kg/m^2).

Protocol

Muscular Strength: Muscular strength was assessed through the measurement of grip strength with a Jamar hydraulic hand dynamometer (Lafayette Instrument, model J00105) using the ACSM's Static Handgrip Strength Test procedures (4). Handle position number 2 was used for all participants as recommended by previous research (51). Participants self-identified their preferred hand and performed the test three times. The highest score was recorded (in kilograms) for each participant. Handgrip dynamometry has demonstrated excellent test-retest reliability in community dwelling older adults (1) and validity in healthy adults (31; ICC = 0.99 with Jamar dynamometer).

Static Balance: Static balance was assessed with a One-Legged Stance Test (OLST) on a firm surface with eyes open. Participants self-selected the leg on which they performed each trial. Participants were instructed to stand on their preferred leg with hands resting on their hips while maintaining a fixed gaze on a spot at eye level in front of them. Time began when their non-balancing foot left the ground and continued until one of the following criteria was met: a) non-balancing foot touches the ground, b) hands leave hips, c) support foot moves noticeably from starting position, d) non-balancing leg provided support to balancing leg, or e) 30-seconds elapsed. Time was recorded to the hundredth of a second. The OLST has shown good reliability in assessing balance, with eyes open, in health older adults (ICC=0.99) (48). Mancini & Horak recommended use of eye-open version of the OLST in older adults (32).

Mobility: The Timed Up and Go (TUG) (39) was used to assess functional mobility. Participants began the test in a seated position with their backs against the back of a standard chair, utilized for group chair exercise programs at the facility, with no armrests. On the tester's command, the participant stood, walked 3 meters to a marking on the ground, turned around, walked back to the chair, and sat down. Participants were instructed to "walk at your regular pace" (39). Time began on the tester's command and stopped when the participant sat down with back once again resting on the backrest. The TUG test has been shown to be a valid measure for screening fall risk in elderly individuals (5).

Fall Efficacy: Fear of falling has been demonstrated to negatively influence physical activity levels in healthy older adults (12). The Fall Efficacy Scale-International (FES-I) (56) is a 16-item survey that assesses fear of falling using a four point Likert-like scale (1 = "not at all concerned" to 4 = "very concerned"). Participants were asked to rank their fear of falling while performing common activities of daily living (e.g., *Going to answer the phone before it stops ringing*). The FES-I demonstrated excellent test-retest reliability (ICC = 0.96) and internal validity (α = 0.96) (56). A total fall efficacy score was generated by summing the 16-items. Scores could range from 16 (not at all concerned about falling) to 64 (very concerned about falling).

Self-Efficacy for Activities of Daily Living: The Self-Efficacy for Activities of Daily Living (22) is a 70-item survey that assesses participants' self-perceived confidence to carry out activities in seven subsections: a) walking (14 items), b) sexual intercourse (5 items), c) jogging (15 items), d) total physical exertion (5 items), e) climbing stairs (9 items), f) lifting objects (12 items), and g) push-ups (10 items). Each section presents tasks of increasing difficulty. For example, in section 7 (push-ups), question 1 states "I am confident that I can perform push-ups at a steady pace without stopping for: 1 push-up" and question 10: "40 push-ups." Participants used a 10-point Likert-like self-assessment scale (1 = quite uncertain (10%) to 10 = extremely certain (100%)) to indicate their confidence in being able to accomplished the listed task. Self-efficacy scores for each subsection were generated by summing the items for successive levels of the task (e.g., walk 1 block, walk 2 blocks, walk 1 mile) and dividing by the number of levels (e.g., 14 levels for walking). An overall self-efficacy for activities of daily living (SE-ADL) was calculated by adding the subscales.

Group Exercise Survey: A group exercise survey was developed by the researchers to assess participants' exercise motivations and beliefs. The 10-item survey asked participants to assess their agreement with statements relating to exercise and wellness (e.g., "I enjoy exercising," "I feel strong," etc.) using a 5-point Likert-like scale (1 = completely agree, 5 = completely disagree). Four additional statements and one open-ended question were added to the post-test survey to assess participants' use of the HRED (e.g., "I would like to continue exercising with the HRED, DoubleFlex ®").

Secondary Measures: An automatic blood pressure monitor (Omron Healthcare, Model HEM-711), administered by a certified nursing assistant, recorded resting heart rate (beats per minute) and blood pressure of all participants prior to all other psychometric data collection. Subject height (in inches) and weight (in pounds) were assessed using a physician scale

(Detecto model 439) by a trained technician. BMI was calculated using weight in pounds divided by height in inches squared and multiplying by 703.

Instrument: The HRED, the DoubleFlex®, (OYO Fitness, Kansas City, MO) was selected to provide variable resistance during exercises across the intervention (see Figure 1). The HRED utilizes interim resistive technology (45) in a lightweight (approximately 2 pounds) handheld format. The HRED allows users to perform multi-planar movements while varying resistance between 5 and 15 pounds with a minimal increase in unit weight. The HRED is designed to accommodate both upper and lower (with provided leg-straps) extremity exercises.

Figure 1. Handheld resistive exercise device (L) back pull, (R) chest press.

The study utilized a one group pre- and post-test design with a 10-week exercise intervention period. Participants attended an informational meeting the week prior to baseline testing that described the purpose of the research study, introduced the HRED, and provided opportunities for questions and answers. Informed consent was collected in compliance to Institutional Review Board policies (reference number: 2016-CAS-33). Participants then completed baseline testing of all primary and secondary biometric and psychometric variables. All testing was conducted inside the group exercise facility on the retirement community campus under direct supervision of the researchers and assisted by trained undergraduate kinesiology students and exercise facility personnel.

The exercise program was administered in the group exercise facility twice per week for 10 consecutive weeks during fall 2016. The exercise intervention was specifically developed to utilize the HRED with an older adult population. Table 1 provides a list of exercises used across the 10-week exercise intervention. Although 30 exercises are listed, many of them could be used in combinations, giving instructors a range of over 56 exercises from which to choose. For example, performance of a sit-squat with chest press to back pull incorporates three exercises into one.

The exercise program was designed to encourage increased familiarity and facility with the HRED, as well as increased strength, flexibility, and stamina. This was accomplished through the introduction of a steady progression of exercises such that as participants mastered basic level exercises with the HRED, increases in difficulty (i.e., changes in duration and intensity) were presented. A range of warm-up exercises were used to prepare participants for exercise and to prevent joint and muscle injury (9). Immediately following warm-ups, instructors led participants in a series of exercise circuits, each followed by a brief recovery period. Warm ups, cool downs, and exercises were completed standing or seated, as directed by the instructor. Each exercise session lasted 45 minutes, including warm-up, cool-down, and 30-35 minutes of exercise. All sessions were led by trained and certified instructors who used templates each week to plan and track the progression of exercises and to encourage both flexibility and novelty of the design for each session. Trained undergraduate kinesiology students acted as fitness assistants, helping participants with form and offering in-class assistance as needed.

Table 1. Sample exercise.

Upper Extremities Exercises	Region Worked
DoubleFlex® crunch	Core
Torso twist	
Toe dip	
Biceps curl	Biceps
Foldover	
Chest press	Chest
Straight arm chest press	
Overhead chest press	
Low chest press	
Incline chest press	
Back pull	Middle & upper back
Overhead back pull	
Lat pull down	
Low back pull	
Anchored lat side raise	
Chest-back	Chest & upper back
Overhead chest-back	
Low chest-back	
Shoulder press	Shoulders
Arrow pull	
Triceps press	Triceps
Lower Extremities Exercises	
Step-out side squat	Hips & thighs
Sumo squats	
Stationary lunge	
Reverse lunge	
Side lunge	
Step-out hinge	
DoubleFlex® adductor press	Hip adductors
Calf raises	Lower legs

To support and encourage optimal progression of resistance training, a tiered approach to circuit duration was used. As shown in Table 2, exercise sessions for weeks one through five included two distinct circuits repeated twice, with 30 seconds for each exercise and a 45 second recovery between each circuit. During weeks six through eight, three distinct circuits were used, with 40 seconds for each exercise performed, and 45-60 seconds of recovery between each circuit. Weeks nine and ten utilized the same structure as weeks one through five.

Table 2. Exercise progressions.

Weeks 1 -5	Weeks 6-8	Weeks 9 & 10
Warm-up (5-7 minutes)	Warm-up (5-7 minutes)	Warm-up (5-7 minutes)
Circuit 1: 8 exercises @ :30s	Circuit 1: 8 exercises @ :40s	Circuit 1: 8 exercises @ :30s
Recovery- :45s	Recovery- :60s	Recovery- :45s
Repeat circuit 1	Circuit 2: 8 exercises @ :40s	Repeat circuit 1
Recovery- :45s	Recovery- :60s	Recovery- :45s
Circuit 2: 8 exercises @ :30s	Circuit 3: 8 exercises @ :40s	Circuit 2: 8 exercises @ :30s
Recovery- :45s	Recovery- :60s	Recovery- :45s
Circuit 2: 8 exercises @ :30s	Cool Down (5-Minutes)	Circuit 2: 8 exercises @ :30s
Recovery- :45s		Recovery- :45s
Cool down (5-Minutes)		Cool down (5-Minutes)

Table 3. Sample circuits.

Week 2 Example	Week 9 Example
Warm-up (5-7 minutes)	Warm-up (5-7 minutes)
Circuit 1: (8 exercise @ :30)	Circuit 1: (6 combo exercise @ :30 unless noted otherwise)
- Chest-back	- Chest-back (60s)
- Biceps curl left	- Biceps curl left to triceps press right
- Biceps curl right	- Biceps curl right to triceps press left
- DoubleFlex® crunch	- Sit-squat with chest press to overhead Back pull
- DoubleFlex® hip adductor press	- DoubleFlex® torso twist with chest press
- Toe dip with HRED	- DoubleFlex® hip adductor (60s)
- Arrow pull left	Recovery (:45s)
- Arrow pull right	Circuit 1 (as above)
Recovery (:45s)	Recovery (:45s)
Circuit 1 (as above)	Circuit 2: (7 combo exercises @ :30 unless noted otherwise)
Recovery (:45s)	- Side lunge with foldover (alternate L/R)
Circuit 2: (8 exercises @ :30)	- Low chest press to arrow (alternate L/R)
- Foldover left	- Shoulder press (L) with step-out
- Foldover right	- Shoulder press (R) with step-out
- Sit-squat	- Sit-squat to torso twist and chest press (60s, alternate sides)
- Calf-raises	- High chest to lat pull down and step-out
- Low chest press	- Toe dip with inclined chest-back
- Anchored lat side raise left	Recovery (:45s)
- Anchored lat side raise right	Circuit 2 (as above)
- Torso Twist	Recovery (:45s)
Recovery (:45s)	Cool down
Circuit 2 (as above)	
Recovery (:45s)	
Cool down	

Concurrently, a progression of intensity in exercises was also employed to encourage optimal results and deter a plateau effect. The unique design of the HRED used for this study allowed participants to add additional weight in 5 pound increments to the device (up to 15 pounds total). This was encouraged by instructors starting at Week 5. By this point, all exercises had been introduced and subjects had gained a level of comfort in performing exercises with the HRED device. Additionally, the array of over 50 different exercises that could be used to exercise all the major muscle groups of the body (see Table 1) allowed for a progression of exercise intensity through exercise combinations.

As the study commenced, simpler, isolation and single-joint exercises (e.g., bicep curl, chest press, etc.) were used to improve strength, flexibility, and familiarity with the device. By the end of the study, participants were being instructed to perform complex, compound exercises as part of the circuits (e.g., side lunge with a foldover). See Table 3 for an example of the differences between a circuit used during Week 2 and Week 9.

Statistical Analysis

Statistical analyses were conducted using SPSS (version 24; IBM Corp., Armonk, N.Y.). Paired-sample t-tests were used to evaluate significant changes in primary variable across the 10-week intervention. Descriptive statistics at baseline and post-intervention were calculated for primary and secondary measures with mean ± standard deviation and/or frequency percentages reported.

RESULTS

Demographics: Twenty-eight healthy older adults participants completed the study. Participants attended, on average, 93.4% of the exercise sessions (□ = 18.7, low = 12) available during the 10-weeks of the study. Table 4 shows demographical information at pre- and post-intervention. There were no significant differences in demographic variables by gender at pre- or post-intervention. Fifty percent (n=14) of participants were classified as overweight (n=9) or obese (n=5) using BMI score of >26 and >30, respectively.

Table 4. Demographics at pre- and post-intervention (n=28).

Participate Demographics	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)
Age (years)	76.6 ± 6.7	76.9 ± 6.9
Height (inches)	65.6 ± 3.6	65.2 ± 4.0
Weight (pounds)	159.6 ± 30.9	160.4 ± 31.2
Systolic blood pressure (mm Hg)	147.3 ± 19.8	145.6 ± 22.8
Diastolic blood pressure (mm Hg)	76.5 ± 10.8	75.5 ± 11.8
Resting heart rate (bpm)	71.9 ± 12.7	73.1 ± 9.0
BMI (kg/m^2)	26.1 ± 4.4	26.5 ± 4.3

Muscular Strength: Figure 2 displays the handgrip strength changes from pre- to post-intervention. There was a significant increase in handgrip strength (t = 7.93, df = 27, p < 0.01) when comparing post-intervention and pre-intervention scores. This significant increase was persistent by gender with males (t = 3.18, df = 6, p = 0.02) and females (t = 7.24, df = 20, p < 0.01) both showing improved grip strength when comparing post-intervention and pre-intervention scores, 39.9 ± 7.2kg vs 35.9 ± 6.0kg and 26.4 ± 5.3 vs. 21.6 ± 4.7 respectively.

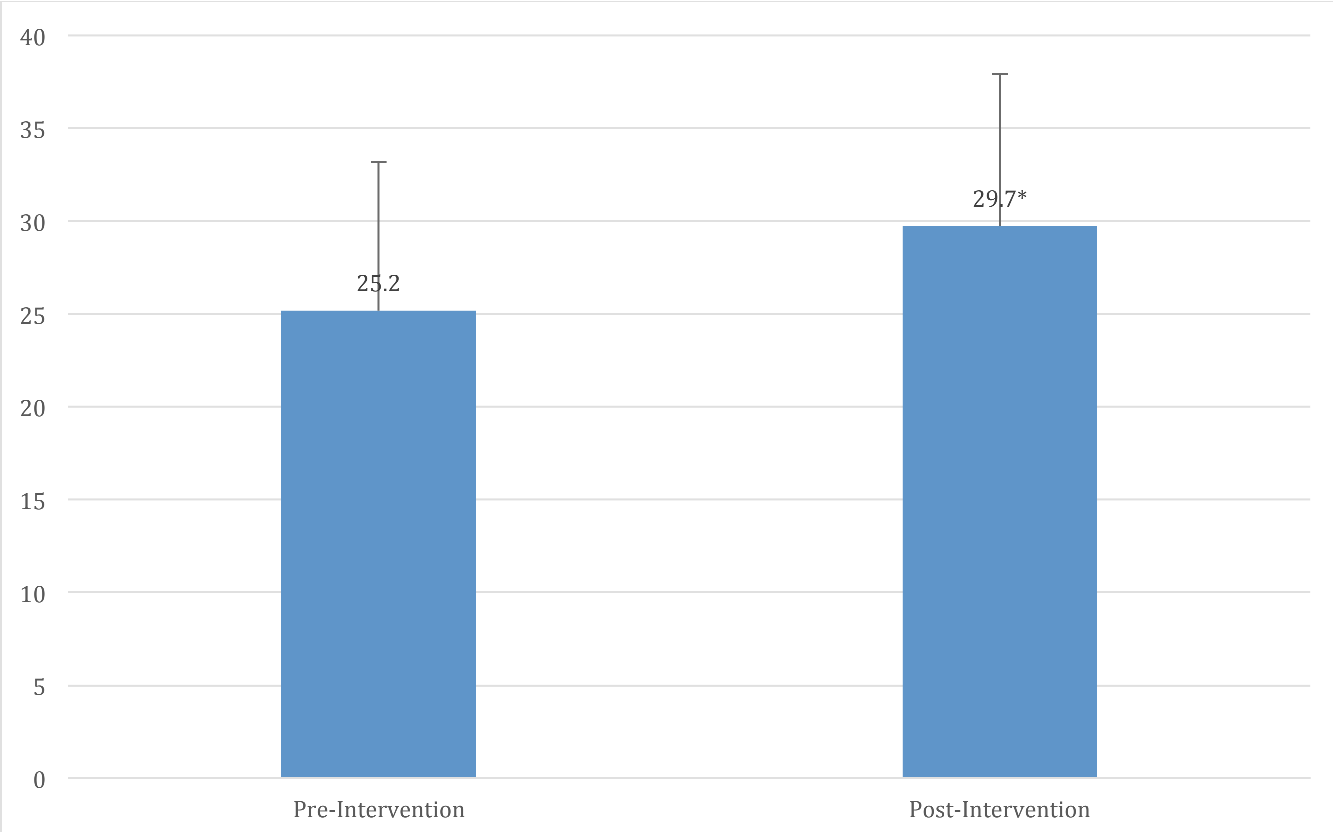

Figure 2. Muscular strength at pre- and post-intervention (force in kg). *p<0.01

Static Balance: Figure 3 displays the OLST score at pre- and post-intervention. There was no significant change in static balance (t = 1.17, df = 27, p = 0.25) when comparing post-intervention with pre-intervention scores. There was no difference between or within gender with regards to the static balance scores.

Mobility: Figure 4 displays the TUG test scores at pre- and post-intervention. There was a significant improvement (decrease) in time needed to perform the TUG test (t = -4.23, df = 27, p < 0.01) when comparing post-intervention and pre-intervention scores. There was no difference by gender at pre- or post-intervention. Females showed significant improvement (decrease) in time when comparing post-intervention (9.2 ± 2.1 seconds) with pre-intervention (11.0 ± 2.6 seconds), t = -4.34, df = 20, p < 0.01). Males showed an overall, although not significant, improvement (decrease time) in the TUG test. Figure 5 identifies the average TUG time by age groups. At pre-intervention 25% (1 of 4) of 60-69 year old, 33.3% (5 of 15) of 70-79 year old, and 55.6% (5 of 9) of 80-89 year old participants met the referenced value (10) while at post-intervention 75% (3 of 4), 60% (9/15), and 88.9% met the reference values, respectively.

Fall Efficacy: There was no significant change in fall efficacy scores (t = 0.55, df = 26, p = 0.59) with comparing post-intervention (19.4 ± 4.3) and pre-intervention (19.1 ± 3.2) scores. There were no between or within differences by gender with regards to fall efficacy scores. The scores ranged from 16 to 28 at pre-intervention and 16 to 35 at post-intervention, indicating a low level of fear of falling in participants.

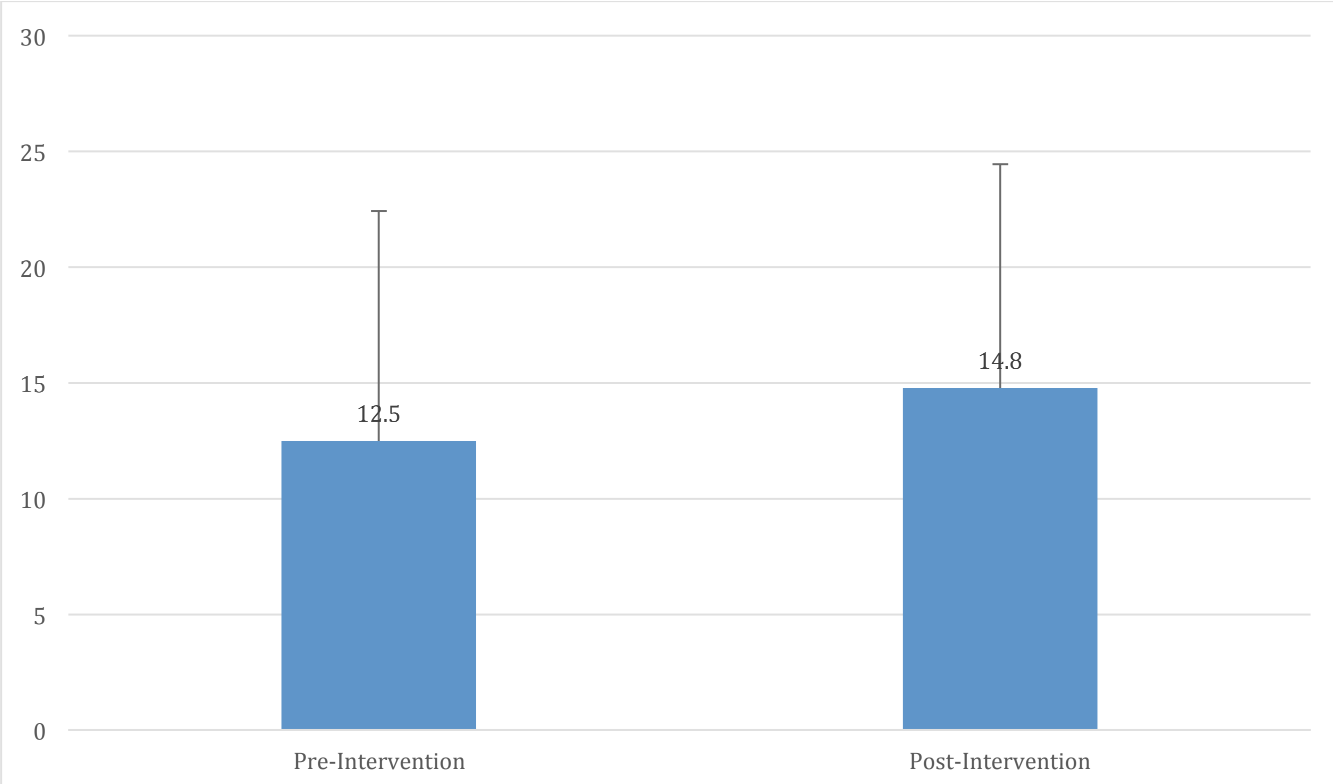

Figure 3. Static balance at pre- and post-intervention (time in seconds).

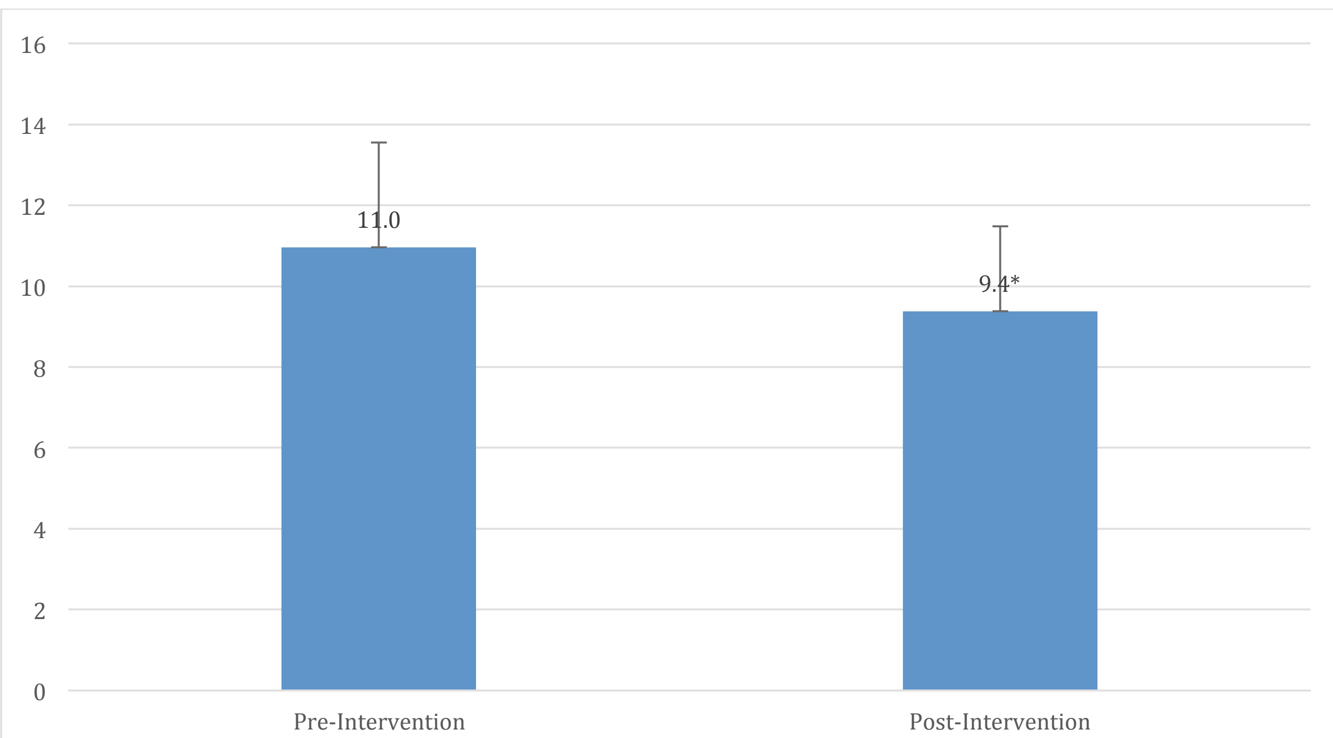

Figure 4. Mobility at pre- and post-intervention (time in seconds). *p<0.01

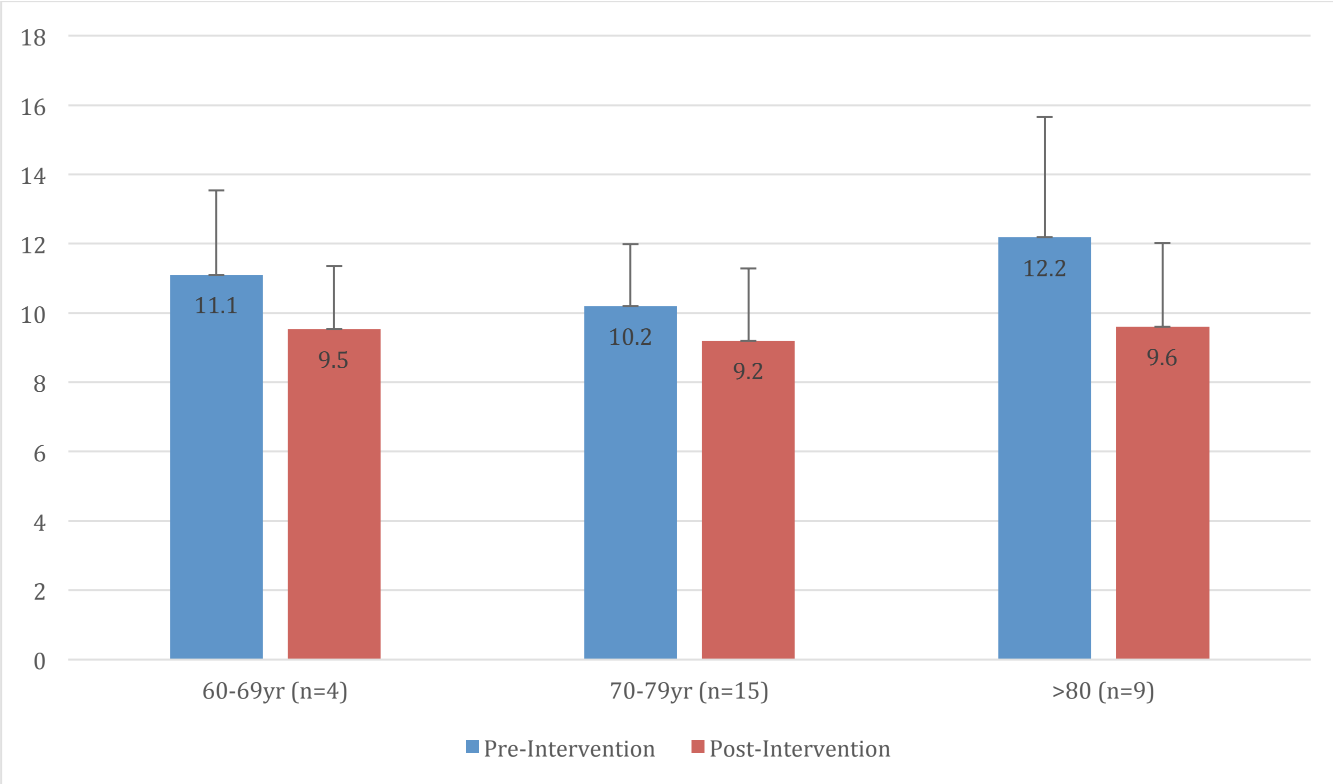

Figure 5. Mobility at pre- and post-intervention by age group.

Self-Efficacy for Activities of Daily Living: The seven self-efficacy scale scores at pre- and post-intervention are displayed in Table 5. Results indicated significantly lower self-efficacy for walking at post-intervention (t = -2.31, df = 25, p = 0.029). Twenty-three (82.1%) indicated they had 100% confidence in their ability to walk 1-block at pre-intervention whereas eighteen (64.3%) reported 100% confidence at post-intervention. At each level, the percent of respondents indicating ≥ 80% confidence in completing the task was greater at pre-intervention than at post-intervention. There was a significant increase in self-efficacy for jogging at post-intervention (t = 2.22, df = 25, p = 0.036). Four (14.3%) indicated they had 100% confidence in their ability to jog 1-block (level 1) at pre-intervention whereas seven (25.9%) reported 100% at post-intervention. The number of participants indicating ≥ 80% confidence was greater at post-intervention at all levels. No participants indicated ≥ 80% confidence past level 4 (jogging 4-blocks) at pre-test whereas at least 2 (7.4%) indicated 100% confidence up to level 12 (jogging 3.5 miles) at post-intervention. There was significantly greater self-efficacy for push-ups at post-intervention (t = 2.11, df = 26, p = 0.045). Eleven (39.3%) indicated 100% confidence in their ability to perform 1-push-up (level 1) at pre-intervention whereas 16 (57.1%) had similar confidence at post-intervention. More participants at post-intervention reported ≥ 80% confidence in their ability to perform push-ups at levels 1 through 4 (1 to 10 push-ups). No respondents at pre- or post-intervention indicated ≥ 80% confidence in performing 25 (level 7) or more push-ups. No significant changes were observed with regards to self-efficacy for Sex (p = 0.166), total physical exertion (p = 0.649), stair climbing (p = 0.244), lifting (p = 0.805), or total self-efficacy for activities of daily living (p = 0.266).

Table 5: Self-Efficacy for Physical Activity

Self-Efficacy Subscale	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)
Walking	75.5 ± 21.3	69.9 ± 21.9
Jogging	21.6 ± 14.1	31.2 ±24.9^
Physical exertion	85.3 ± 11.7	83.9 ± 13.9
Stairs	63.1 ± 20.7	66.5 ± 19.8
Lifting	43.0 ± 22.5	42.4 ± 23.6
Pushups	25.7 ± 18.4	33.0 ± 20.5^
Sex	51.0 ± 33.8	58.6 ± 30.0

^ $p < 0.05$

Group Exercise Survey: There was no significant change in total group exercise scores (t = 0.917, df = 27, p = 0.367) when comparing pre- (15.9 ± 4.8) and post-intervention (15.2 ± 4.2) summary scores, where a lower score indicates strong agreement with affirmative statements (e.g., "I enjoy exercising"). "completely agree" or "agree" percentages ranged from 75.0% (question 7, "I feel flexible") to 100% (two questions) at pre-intervention, and from 78.6% (question 7) to 96.4% (three questions). Four additional scaled-questions and one open-ended question were added at post-intervention to assess the efficacy of the HRED in older adults. Twenty-six participants (92.9%) completely agreed or agreed that they would "like to continue exercising with the DoubleFlex®", 21 (75%) noted that they "can complete activities of daily living easier than before," 15 (53.6%) reported that they "can complete activities now that I couldn't before the study," and 24 (85.7%) replied that "the DoubleFlex® is a great fitness device for older adults." Only one participant (3.6%) disagreed with any of these statements.

The open ended question "*What mental or physical changes do you attribute to exercising with the DoubleFlex*" generated four themes: a) improved strength, b) improved balance, c) improved flexibility, and d) changes to daily activities. With regard to strength, 19 (67.86%) indicated they felt stronger. One female stated "I feel stronger and I love it!" and another wrote "I can open cans and jars." A female participant indicated that she could "drive golf balls further" and one male participant wrote that his "strength has improved and core strength is better than it was." Five participants (17.86%) highlighted improvements in balance (e.g., "My balance has improved"), and four (16%) spoke to having "more stamina to continue activities" and "more flexibility."

DISCUSSION

The primary purpose of this study was to examine the efficacy of HRED training on wellness outcomes in older adults. It was hypothesized that a 10-week HRED exercise program would result in positive changes in wellness outcomes. A secondary purpose was to assess the utilization of a HRED in older adult fitness program. The results of the present study suggest that a 10-week multi-component HRED program positively impacts wellness outcomes in older adults. Results also support the use of HREDs in exercise programming for older adults.

HRED Training on Wellness Outcomes in Older Adults: Muscular Strength: The results of this study demonstrated significant improvements in muscular strength (p < 0.01) following 10-weeks of HRED training (see Figure 1). Handgrip strength is routinely used as a prognostic tool to assess health and wellness outcomes associated with healthy aging (29). Improved grip strength is associated with improvements in functional ability (28), physical activity levels (43), and cardiovascular disease biomarkers (29). Similarly, increases in grip strength are negatively correlated with measures of frailty (40), short- and long-term mortality risk (36), and metabolic syndrome prevalence (44). Our results are similar to Fien (23), who demonstrated significant improvement in grip strength in older adults following a 12-week resistance exercise program.

Static Balance and Mobility: There was no statistical change (p = 0.25) in static balance following the 10-week HRED training program (see Figure 2). These results are contrary to what was hypothesized and what has been found previously in exercise interventions in older adults. However, researchers found similar non-significant changes in balance following an 18-week resistive band exercise program for older adults (13). The single trial on the OLST with eyes open may not have been adequate to accurately assess static balance in our participants. The HRED training program focused on functional movements that utilized dynamic movements rather than static balance. As might be expected, although no significant changes were found in static balance, participants did show significant improvement in the TUG test ($p < 0.01$, see Figure 3), a functional movement assessment. At pre-intervention 39.3% (11 of 28) met referenced values for TUG (10) while at post-intervention this increased to 71.4% (20 of 28). Faster TUG times have been associated with improved executive function and mental flexibility (35), as well as lower risk of falling (39). It is important to note that participants commenced and ended the program with TUG scores below the fall risk criterion (13.5 seconds, 39). This may be the result of our use of healthy, fully independent living residents. However, it is important to recognize that the majority of participants moved closer to their age-related norms. This may provide clinical relevance when working with older adults at greater risk of falling.

Fall Efficacy & Self-Efficacy for ADL: The 10-week HRED training program did not elicit changes in fall-efficacy in our participants (p = 0.59). The participants in this study were healthy older adults that had a recent history of engaging in physical activity and similar fitness programming. As such, the FES-I may not have been sensitive enough to distinguish between pre-intervention and post-intervention perceptions of fear of falling associated with various activities of daily living. Table Three shows the pre- and post-intervention scores for the seven self-efficacy scales calculated from the self-efficacy for daily living questionnaire (22). Results demonstrated significant improvements in self-efficacy for jogging (p = 0.036) and push-ups (p = 0.045) and a significant decrease in self-efficacy for walking (p = 0.026) at post-intervention. The walking results are counterintuitive following the 10-week HRED training. Walking was a common mode of physical activity used by the participants in this study. As such, they may have developed a more keen sense of their ability to critically analyze an activity they regularly participated in and this may account for these results. To address changes in self-perceived ability to complete common activities (such as walking), future research should consider adding a functional test aspect in addition to self-efficacy measures.

HRED Utilization for Older Adult Exercise Programming: The high rate of attendance (mean 93.4%) indicates that HRED training can be successfully integrated into older adult exercise programming. The four questions added to the group exercise survey at post-intervention sought to address the willingness of older adults to use the HRED. Participants overwhelming indicated (92.9%) that they would "like to continue exercising with the DoubleFlex®" and 85.7% thought that "the DoubleFlex® is a great fitness device for older adults." Anecdotally, 26 of 28 (92.9%) participants returned to the fitness facility for an "Advanced DoubleFlex®" course offered at the completion of this study. Feelings of fun and enjoyment have been associated with exercise adherence in older adults (27, 42) and it appears that the DoubleFlex® may help motivate older adults to remain physically active.

The present study utilized a population of healthy older adults with a history of engagement in physical activity. This may limit the generalization of the findings as a large percentage of older adults remain physically inactive (33). Additionally, the study was designed and implemented without a control group. As such, the results may not be unique to 10-weeks of HRED training. The FES-I has been utilized in a variety of populations and settings. However, it may not be sensitive enough to observe changes in fear of falling in older adults with active lifestyles. Our decision to use a single assessment for static balance may not have adequately evaluated balance changes in this population following 10-weeks of dynamic movement training. Likewise, the dynamic nature of the exercise movements may have contributed to the significant improvement in TUG times that would not be evident in programs that are more stationary (i.e., chair-based exercise routines). Lastly, the participants were allowed to self-regulate the resistance utilized with the HRED device. Their decision to increase, decrease, or maintain a level of resistance may not be generalizable to typical older adults. Each of these limitations provide opportunities for future research.

Future research is needed to assess the impact of HRED training on self-efficacy in older adults. Interventions designed to compare HRED training to traditional older adult exercise programming (e.g. resistance bands, free weights) are needed to better understand the efficacy of HREDs to elicit changes in muscular strength and endurance. The addition of objective measures of muscular strength and endurance beyond hand grip dynamometry is also needed. Developing interventions to compare the impact of HRED training on muscular strength and endurance changes by gender is also warranted. HRED training demonstrated improvements in mobility and dynamic balance but not static balance in older adults. Additional research is needed to explore the impact of resistance training on balance in this population.

The current study provides evidence that a 10-week HRED training program can elicit health benefits in older adults. The HRED (DoubleFlex®) provided individualized regulation of resistance and facilitated the use of progressive resistance training. Participants overwhelmingly enjoyed using the DoubleFlex® (92.9%) demonstrating that HREDs can effectively be used in older adult exercise programming. The high rate of attendance also indicates that older adults are motivated to incorporate resistance training into their physical activity routines.

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