Clinical Interventions in Aging

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ORIGINAL RESEARCH

Influence of the Flo-Dynamics Movement System© intervention on measures of performance in older persons

This article was published in the following Dove Press journal:
Clinical Interventions in Aging
15 July 2013
Number of times this article has been viewed

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Background: Fall-related injuries associated with aging are a serious clinical and economic problem. The Flo-Dynamics Movement System© (FDMS), which consists of eight movements with a water-filled device, may be a useful low-impact exercise suited for older persons. This study investigated the effects of the FDMS regimen with the Wun-Jo™ trainer on measures of strength, flexibility, and balance in older individuals.

Methods: In a quasi-experimental study, 15 healthy subjects aged 61–79 years participated in an FDMS exercise program with the Wun-Jo trainer, consisting of three weekly 30-minute sessions. The following measures were assessed pretraining and after 8 weeks of training: knee flexor and extensor isokinetic strength; grip strength; the Short Physical Performance Battery; functional reach; and low back and hamstring flexibility. Data were analyzed using repeated measures analysis of variance, with statistical significance set at the $P \leq 0.05$ confidence level.

Results: Sit and reach test scores significantly increased (+21%) from baseline to week 8 ($P < 0.001$). Forward-left functional reach testing significantly increased ($P = 0.012$), while forward-right functional reach testing did not change ($P = 0.474$). Both left-lateral ($P = 0.012$) and right-lateral ($P = 0.036$) functional reach scores improved. Grip strength increased in both the left (+11.9%) and right (+14.5%) hands ($P < 0.001$ for each). Isokinetic knee extension at 60° per second increased for the left (+15.6%) and right (+17.6%) significantly ($P = 0.001$ for each). Isokinetic knee flexion at 60° per second significantly increased for both the left (+43.2%, $P = 0.010$) and right (+41.7%, $P < 0.001$). Time to complete the ten-repetition chair stand decreased significantly (–31%, $P = 0.004$). The 8-feet walk time also significantly decreased (–21.6%, $P < 0.001$).

Conclusion: Participating in the FDMS with the Wun-Jo device may improve balance, low back and hamstring flexibility, walking speed, and knee extensor/flexor and grip strength in older individuals. FDMS training provides an alternative to traditional exercise and offers an effective strategy to increase functional ability in the elderly.

Keywords: exercise, aging, balance

Introduction

A loss of functional fitness and the ability to perform daily tasks may be associated with aging. This decrease in functionality and subsequent decrease in strength and the ability to maintain balance often leads to a loss of independence and quality of life.[1,2] Additionally, fall-related injuries are serious problems in older persons, which often lead to prolonged or even permanent disability.[3–5] The relevance of aging-related injuries such as falls is considerable, given that the elderly population is projected to increase over the years.[6] Several researchers have reported that greater declines in physical function occur as persons age, which results in a greater likelihood of falls.[7]

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Deterioration in physical characteristics such as balance, leg extension strength, and gait has consistently been identified as a major risk factor for falls among the elderly.[8] Exercise has been shown to improve an elderly person's ability to perform activities of daily living independently [1,2,9–11] and reduce the risk of falls.[12]

Exercise training is widely considered to be an effective nonpharmacologic way of reducing physical difficulties in older people. A review of randomized controlled trials has demonstrated that exercise reduces the risk of falls in elderly people, and reduction in the incidence of fall-related injuries is related to lower health care costs.[13] Previous research has documented that the force-generating capacity of human muscle[14] and subsequent balance and flexibility declines with increasing age, especially after the age of 60 years.[4,15] Chu et al reported that older persons with incident falls were 2.4 and 4.6 times more likely, respectively, to become decliners in gait speed and total mobility score testing, which includes sums of balance and gait scores, as compared with nonfallers.[3] Exercise programs for the elderly focused on strength and balance are critical in fall prevention.[16] Balanced-based exercise programs performed 3 days per week were found to decrease falls in elderly individuals with a history of falls.[17] Several investigators have reported that strength and flexibility are collectively improved by exercise in older persons.[18–20]

An increasing body of data shows that programs involving muscle strengthening and balance are beneficial in reducing the incidence of falls in the elderly.[4,5] Wu[21] and Wu et al[22] found that elderly persons participating in Tai Chi exercise showed improved isokinetic knee extensor strength and less postural sway. Zhang et al have reported that Tai Chi is also effective in increasing balance confidence in older persons.[23] Tai Chi movements are hypothesized to promote sensory awareness, postural control, and muscle strength and coordination.[6,21,22,24] Similar to Tai Chi, the Flo-Dynamics Movement System© (FDMS) consists of a series of slow and continuous movements. This system utilizes the Wun-Jo™ trainer (Wun-Jo, Inc., Morristown, NJ, USA), which is a unique water-filled training device for performing fluid motions designed to improve strength, balance, and flexibility.

The present study was designed to test the efficacy of FDMS training with the Wun-Jo device, and whether this will improve various key performance variables in older persons. We sought to study changes in balance, flexibility, grip strength, knee extensor and flexor strength, and variables of the Short Physical Performance Battery (SPPB) following implementation of the FDMS exercise regimen. It is important to evaluate effective, low-impact, and enjoyable physical activity strategies for older persons, to prevent frailty and loss of independence. It has been suggested that any exercise intervention that improves the SPPB score might delay the occurrence of movement disability in elderly individuals.[25,26] To date, no scientific data exist on the efficacy of FDMS training with the Wun-Jo device. The purpose of this investigation was to determine whether an eight-week intervention using the FDMS exercise regimen with the Wun-Jo training device would improve flexibility, stability, strength, and gait speed in older individuals.

Materials and methods

Participants

Fifteen healthy individuals (five males and ten females, of mean age 71.8 ± 5.2 years, body weight 82.09 ± 15.04 kg, height 1.63 ± 0.10 m, and body mass index 31.06 ± 6.4) were recruited by poster advertisements at various senior places of residence for this study. Following approval by the university's institutional review board, the volunteers were informed of the purpose, procedures, risks, and benefits of the study prior to giving their informed written consent. Exclusion criteria were any disease (eg, emphysema, multiple sclerosis) or orthopedic condition (eg, low back, bone, or joint pain) which would inhibit their ability to exercise safely. All subjects completed an American College of Sports Medicine Physical Activity Readiness Questionnaire form[27] to ensure eligibility for participation and were also cleared by their physician prior to participation.

Procedures

Following familiarization with FDMS training and the Wun-Jo device (standard class protocol), participants attended a 30-minute structured FDMS class 3 days per week for a total of 8 weeks. During the familiarization period, participants were instructed on all eight of the required movements necessary to be able to complete a 30-minute structured class. The purpose of this period was to ensure that the actual training sessions were focused on completing the 30-minute exercise protocol, and not on learning how to use the Wun-Jo device and basic movements. Each FDMS class consisted of eight basic movements (Figure 1) that were repeated for 30 minutes. All exercise classes, including familiarization training, took place at a fitness studio (B-Fit, Scarborough, ME, USA), and attendance was taken at all exercise training sessions to confirm participant adherence. A minimum of one day of rest between classes was required. Each Wun-Jo training device was filled with enough water

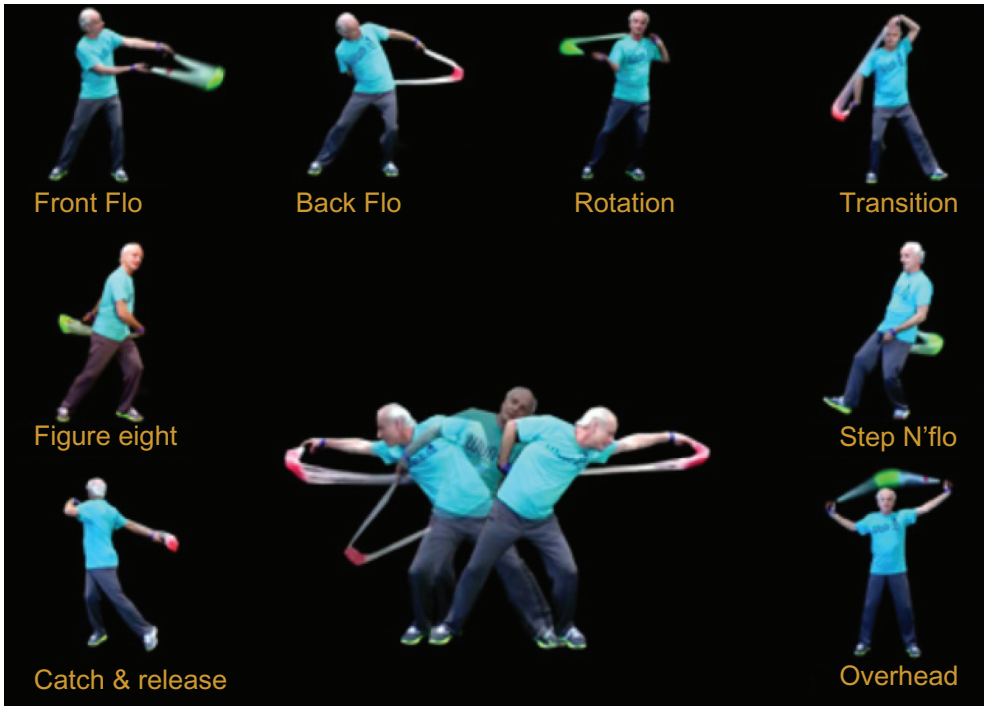

Figure 1 Eight basic movements of the Flo-Dynamics Movement System©.

to weigh 1.02 kg. All Wun-Jo devices were weighed weekly throughout the 8-week study period to confirm the mass of the device.

Participants were tested on two separate training sessions (baseline and after 8 weeks) on the same schedule after a 5-minute warmup on a Monark cycle ergometer (Model Ergomedic 828E, Varberg, Sweden) at 50 rpm and 25 W prior to testing. Participants were instructed not to engage in exercise during the 24 hours before each testing session. In addition, participants were instructed to abstain from food, tobacco, alcohol, and caffeine before attending exercise testing. All testing took place at the same time of day in the University of New England Human Performance Laboratory at the Orthopedics Associates Facility in Saco, ME, USA. Each testing session consisted of the following assessments:

- Short Physical Performance Battery
- Functional reach test
- Sit and reach test
- Grip strength
- Strength assessments of the thigh muscles

Mobility and balance assessments

Participants completed the SPPB, which included measures of static balance (normal, semitandem, and tandem foot positions), strength and endurance (ability to rise and return to a seated position five times or ten times as per the SPPB protocol), and gait (time taken to walk 2.4 m). A functional reach test was used to measure both forward and lateral balance as each participant stood against a wall and reached forward or laterally as far as possible while maintaining balance. Each subject attempted three trials and the maximum distance reached was recorded for both right and left sides for both forward and lateral reaches. Hamstring and low back flexibility was measured using a Flex-Tester sit-and-reach box (Novel Products, Rockton, IL, USA). While sitting on the floor, participants placed both hands together, and reached as far forward as possible. The best of three attempts was used for analysis.

Strength assessments

Bilateral grip strength was tested using a Jamar hydraulic hand dynamometer (Sammons Preston Rolyan, Bolingbrook, IL, USA). Participants were given three attempts to attain as high a rating as possible. An isokinetic dynamometer (Biodex Medical Systems Inc, Shirley, NY, USA) was used to measure peak torque generated by knee flexors and extensors at two different speeds (60° and 180° per second) for each limb. All subjects were positioned with approximately 90° of hip flexion, and stabilization straps were placed over the waist and thigh. The knee joint was aligned with the center of rotation of the lever arm, and the lever arm was attached just above the ankle joint. Subjects were familiarized with

the equipment and given three practice trials at each angular speed. Testing occurred between approximately 100° of knee flexion and full knee extension. Subjects were then instructed to extend and flex their knee with as much force as possible for ten repetitions at each speed for each limb. Verbal and visual cues (subjects were allowed to view the real time output from the Biodex) were provided for the subjects. Maximal torque production from each trial of ten repetitions was used for data analysis.

Statistical analyses

All data were assessed for normality of distribution using Kolmogorov–Smirnov tests. Data are shown as the mean ± standard deviation. Changes in strength and flexibility measured were compared at baseline and after 8 weeks of training using a repeated measures analysis of variance. In the event that a variable was found not to be normally distributed, a related-samples McNemar test was used in lieu of analysis of variance to test for differences in the variable between baseline and 8 weeks. All data were analyzed using computer software (Statistical Package for the Social Sciences version 20, IBM, Armonk, NY, USA). Statistical significance was set at the two-tailed $P \leq 0.05$ level of confidence.

Results

Kolmogorov–Smirnov tests indicated that most variables tested were normally distributed ($P = 0.147$–0.987) except for the static balance tests in both normal and tandem foot positions ($P = 0.023$ for both). Fifteen subjects completed the 8-week exercise training and all assessments at baseline and week 8. Subjects' body mass ($P = 0.683$) and body mass index ($P = 0.183$) were unchanged over the 8-week program.

Mobility and balance measures

Static balance scores for the SPPB assessment (normal, semitandem, and tandem foot positions) were not altered over the intervention ($P > 0.05$). Times for the SPPB five-repetition chair stand did not change ($P = 0.078$), while times to complete the 10-repetition chair stand decreased significantly (–31%, $P = 0.004$). The SPPB 8-feet walk times were also significantly decreased (–21.6%, $P < 0.001$). The forward-left functional reach test significantly increased (+6.5%, $P = 0.012$), while the forward-right functional reach test did not change ($P = 0.474$). Both left-lateral ($P = 0.012$) and right-lateral ($P = 0.036$) functional reach scores improved. Sit and reach test scores significantly increased (+21%) from baseline to week 8 ($P < 0.001$).

Measures of muscle strength

Grip strength increased in both the left (+11.9%) and right (+14.5%) hands (Figure 2, $P < 0.001$ for each). Isokinetic knee extension and flexion changes are shown in Table 1. Isokinetic knee extension at 60° per second was significantly increased for both the left (+15.6%) and right (+17.6%) knee

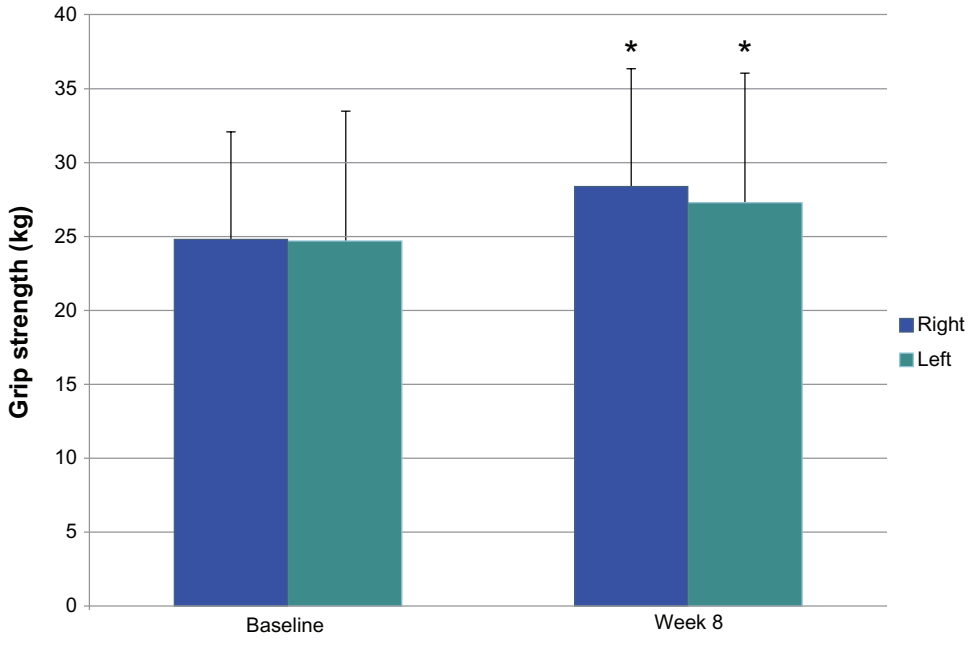

Figure 2 Grip Strength.
Note: *$P < 0.001$ difference from baseline measure.

Table 1 Isokinetic knee flexion and extension strength (Nm)

	60°·s⁻¹				180°·s⁻¹			
	Right		Left		Right		Left	
	Extension	Flexion	Extension	Flexion	Extension	Flexion	Extension	Flexion
Baseline	82.7 ± 28.9	−39.7 ± 14.8	80.1 ± 21.8	−37.7 ± 14.6	62.4 ± 19.3	−36.7 ± 14.8	58.7 ± 18.0	−34.6 ± 10.3
Week 8	97.8 ± 25.6*	−54.9 ± 22.8*	91.7 ± 28.5*	−53.4 ± 23.3*	65.6 ± 19.1	−43.3 ± 16.0	59.9 ± 18.6	−41.6 ± 15.5*

Note: *$P < 0.05$ difference from baseline measurement.

($P = 0.001$ for each). Isokinetic knee flexion at 60° per second was significantly increased for both the left (+43.2%) and right (+41.7%) knee ($P = 0.010$ and $P < 0.001$, respectively). Isokinetic knee extension at 180° per second was unchanged for both the left ($P = 0.614$) and right ($P = 0.233$) knee. Isokinetic knee flexion at 180° per second was significantly increased for the left (+21.7%) knee ($P = 0.035$) but unchanged for the right ($P = 0.057$) knee.

Discussion

Our study aimed to assess changes in balance, flexibility, grip strength, knee extensor and flexor strength, and variables on the SPPB in older persons who participated in 8 weeks of FDMS training with the Wun-Jo trainer. No studies have investigated the impact of the FDMS exercise regimen utilizing the Wun-Jo device on these functional variables. We found an improvement in balance, low back and hamstring flexibility, walking speed, and knee extensor/flexor and grip strength after 30 minutes of structured FDMS exercise using the Wun-Jo device 3 days per week for a total of 8 weeks. These results confirm our hypothesis that older persons participating in structured FDMS training with the Wun-Jo device for 8 weeks show improved performance in a variety of functional tests.

Mobility and balance measures

In the present study, we found that structured low-impact exercise training with the Wun-Jo device was associated with a significant improvement in flexibility, dynamic balance, and gait speed. Flexibility is an important factor for maintaining independence in the elderly[28] and has been shown to be increased by exercise.[18–20,29] It has been documented that Tai Chi, which uses several forms of movements like the FDMS exercise regimen, is beneficial in improving balance in community-dwelling older persons.[30] The exercise regimen focused on movements that required our participants to adjust dynamically to the resistance and movement of the water-filled Wun-Jo device. The eight exercise movements require participants to not only counter the inertia of the Wun-Jo training device mass, but also to control their trunk and upper extremities while maintaining a stable base of support. This is apparent in the positive gains in the functional reach test, which requires participants to maintain their balance throughout a maximal range of motion as compared with the static balance test where no significant changes were observed. Our participants also decreased their times taken to walk 2.4 M, which may be due to enhanced dynamic balance, further indicating the ability to control movement in an unstable position, such as the single leg stance phase of gait.

Measures of muscle strength

Our results corroborate those of other studies of the positive benefits of a low-impact exercise program in older individuals that have found improvements in stability and strength.[19,22,24,31] The improvements in strength observed in our participants after 8 weeks of structured exercise can be associated with the constant effort it takes to counterbalance the resistance from the water-filled Wun-Jo trainer and inertia of the body while completing the exercises. The eight exercises require a series of coordinated, repetitive movements of the lower body joints with the Wun-Jo, which have similar movement characteristics of Tai Chi. The results of our study are consistent with those of several studies reporting that participating in Tai Chi can improve strength in older individuals.[22,24,31]

The existing literature supports the use of balance and strength training in the elderly to reduce the risk of falls.[32] Tofthagen et al reported that balance-specific and strength training appear to be effective for postural control, improving lower extremity strength and thereby reducing the risk of falls.[32] Clemson et al also found that elderly persons at high-risk of falling who participated in balance and strength training using the Lifestyle integrated Functional Exercise (LiFE) program improved and maintained their functional capacity.[33] The results of our study indicate that training with the Wun-Jo device shows promise in reducing the fall risk by improving balance and strength. FDMS training with the Wun-Jo may be another useful exercise tool utilizing low-impact movements for this population. However, further research would need to focus specifically on the Wun-Jo trainer and its effects on fall risk.

Limitations

The limitations of this study are its relatively small sample size, lack of a randomized trial design, and the fact that we focused on a specific patient group, so our results cannot be applied to a broader spectrum of people. Also, the order of testing was standardized, so an effect of order cannot be excluded. Additional studies in larger sample populations are recommended to examine further the positive benefits of FDMS training with the Wun-Jo device on performance variables in older persons. Because this study was an early investigation of the efficacy of this exercise regimen in an older population, future studies may provide further evidence that this type of exercise would be a safe and effective alternative to reduce the risk of falls.

Conclusion

In conclusion, our study provides evidence that older individuals respond with enhanced physical function after 8 weeks of FDMS training with the Wun-Jo device. Moreover, the increases in functional performance suggest that training with the Wun-Jo may increase the ability to perform activities of daily living, prevent falls, and improve quality of life overall for the elderly. Training with the Wun-Jo device following the movements of the FDMS may be a safe and useful exercise regimen to improve physical function in older individuals.

Disclosure

The authors report no conflicts of interest in this work.

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