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Original Research

Efficacy of a 6-Week Suspension Training Exercise Program on Fitness Components in Older Adults

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ABSTRACT

International Journal of Exercise Science 15(3): 1168-1178, 2022. The purpose of this study was to determine the efficacy of a 6-week suspension training exercise program on fitness components in older adults. Eleven participants (age = 80 ± 5 yrs) completed a 6-week suspension training exercise program. Pre- and post-fitness assessments comprised of body composition, handgrip dynamometer, functional reach, and balance. The 6-week suspension training intervention required individuals to perform suspension training exercises for fifty minutes, twice per week. A paired sample *t*-test was used to determine differences from pre-and post-assessments. An improvement was observed in functional reach (57.2 ± 6.4 cm vs 68.6 ± 4.3 cm; p = 0.02) and overall balance score (67.5 ± 2.4 vs 72.2 ± 2.2; p = 0.02). A 6-week suspension training exercise program can be adequate to enhance core stability and overall balance amongst older adults. This paradigm should be explored further to determine the effects on fall-risk and fall prevention.

KEY WORDS: Core stability, gerontology, fall prevention

INTRODUCTION

Suspension training (ST) has been listed as top 10 health/fitness trends for the past 10 years (7). Suspension training is popular because it is simplistic, user-friendly, portable, and predicated upon utilizing an individual's body mass as the solitary source of resistance. Suspension training focuses upon the development of strength, balance, flexibility, and core stability simultaneously (8). The perception of the ST is less intimidating compared to the free weights and machine weights that are commonly seen in commercial gyms, thereby providing certain psychological ease when training with the suspension straps. Moreover, given the bodily angle in which the individual may create with the strap/anchor point, the resistance is scalable, thus accommodating to the varied strength levels of all participants regardless of size, age, experiences, and abilities. Suspension training is commonly seen in commercial/local gyms and utilized by the younger population (i.e., ≤ 54 years of age). Older individuals (i.e., ≥ 55 years of age) living within retirement communities are unfamiliar with the ST modality; therefore, this population warrants further investigation concerning the efficacy of ST.

The U.S. population is aging. By 2030, 1 in 5 Americans is projected to be 65 years old and over (9). There are more than 46 million adults aged 65 and older living in the U.S.; by 2050, it is projected that there will be over three million people worldwide aged 100 years and over (9). Older adults are expected to outnumber children and young adults for the first time in U.S. history in less than two decades (23). The world's population aged 60 years and older is set to rise from 841 million in 2013, to more than 2 billion by 2050, and exceed the number of children by 2047 (4). People aged 65 and over are expected to number 78 million, while children under age 18 will number 76.7 million (21). Lower birth rates and increased longevity have led to rapid growth not just in the United States, but also across the world. The issue of aging is especially important in rural areas because residents tend to be older, on average than those in urban areas. Approximately 20% of an individual's longevity is dictated by familial genetics, while about 80% is influenced by lifestyle and environment (2).

Suspension training could be an effective stimulus to increase core activation, overall stability, and balance, and improved upper- and lower-body muscular strength. Several studies have indicated the lack of physical activity in older adult population groups. In general, older adult population groups are not meeting the required physical activity recommendation of at least 150 minutes of moderate aerobic activity and resistance training on at least two or more days a week. To be more precise, as adults ≥ 50 years progress throughout the remaining decades, there is a significant increase in physical inactivity from 25.4% (50-64 yrs) to 26.9% (65-74 yrs) to 35.3% (≥ 75 yrs) (22). Furthermore, current literature indicates there is a lack of flexibility exercises performed for at least two to three days each week in older population groups (11).

In addition, the Hu and Woollacott study, male and female volunteers participated in a 15-day multisensory balance ST program that examined the electromyographic and kinematic characteristics in older adults (14). Briefly, the multisensory balance training program involved maintaining stability in both static two-leg and one-leg stance. Results indicated a positive trend in the frequency response of stabilizer and antagonist muscle groups of the neck and trunk, thereby increasing the potential for overall stability. Furthermore, the researchers reported a positive effect on muscle structures associated with improved posture following the 15-day training period. A limitation worth noting was the relatively short length of intervention time (i.e., 15 days). Therefore, it would be of interest to replicate said study by using ST, but with greater duration and to assess other fitness components related to older adult population group health metrics. In addition, the aforementioned study was conducted in 1994, when ST was a relatively new modality of training and not yet commercialized at the level it is today. Thus, this study sheds some background as to the early research and use of ST. The results of this study provide earlier evidence and support for further research and use of ST with older population groups as to better ascertain the potential benefits for said population.

More recently in 2017, Boonsit, Peepathum, and Mitranun (1) examined and compared the acute effects of different total body resistance ST exercise postures on flow-mediated dilation in 45 older adult women aged 60-80 years. Participants were randomly divided into three groups. The first group trained with the ST Mid Row exercise, the second group did the ST Squat exercise, and the third group did the ST Chest Press exercise. Participants performed 3 sets and the number of repetitions was determined to be 60% of the maximum repetition. Researchers measured heart rate, systolic, diastolic, and mean blood pressure, baseline and peak brachial diameter, shear rate, blood flow, and flow-mediated dilation. Findings from the study revealed a) the ST Squat and the ST Chest workouts significantly increased systolic blood pressure; b) the ST Mid Row and the ST Chest Press workout significantly increased diastolic blood pressure and blood flow, and c) the ST Mid Row, ST Squat, and ST Chest Press significantly increased mean blood pressure and shear rate. They concluded these three workouts can be used to train muscle strength in older adult women without negatively affecting blood vessels. Although data on physical activity in older adult populations is abundant, there is limited amount of research on suspension training and older adults (3). In 2018, Campa and associates (3) conducted a study to improve upper body muscular strength by changing the angle/position of your body with suspension training in older women. Upper body muscular strength was assessed via a handgrip dynamometer. These researchers suggested that suspension training programs improved older adult's scores on handgrip strength, improved impedance vectors and body composition analyses. In addition, the Campa study implemented a 12-week suspension training protocol utilizing 6 exercises while promoting an increased intensity by way of body position angle. Thus, the Campa study provides a unique comparison to the study presented in this manuscript as the protocol is similar to the research conducted by the authors. However, it should be noted, the subject cohort was comprised of female participants and the Campa study did not assess balance as a data point for analysis. As such, one may not be able to provide generalizable results for an older mixed adult population highlighting a potential limitation of the Campa et al., (3) study.

Given the paucity of data from previous investigations and limitations, more research is needed to clarify the role of ST programming with older adults. To fill in the gaps within the existing literature, the unique aspects of the current study compared with previous studies will include 1) assessing older adults overall balance via NeuroCom Balance Master, 2) assessing stability by way of functional reach test, 3) a specifically designed ST exercise prescription focusing upon core and balance 2 days per week for 6 continuous weeks. Against this backdrop, the purpose of this study was to determine the efficacy of a 6-week suspension training exercise program on fitness components in older adults. It was hypothesized that there will be an improvement between the pre-fitness assessment and post-fitness assessment.

METHODS

Participants

Before participation in the research study, participants were required to meet certain inclusionary and exclusionary criteria. The inclusion requirements were that participants must be 55 years of age or older, must currently exercise at least the recommended amount of 150 minutes of aerobic or resistance training per week, and be independent of an assistive walking device (e.g., walker, rollator, wheelchair, etc.). The exclusionary criteria indicated that all participants must have clearance from their primary care physician and do not require a full-time caretaker. A power analysis revealed that at least ten participants were needed to reach a power of 80% and a level of significance of 5%. Participants were recruited from a local retirement community. The primary investigator or wellness director delivered the consent form at least one day in advance of their appointment time to interested participants. Upon arrival at the institution's Human Performance Laboratory, the informed consent document was presented to the participants to be read/signed/dated. This study utilized data from eleven participants (Males, n = 3; Females, n = 8). This study was approved by the university's Institutional Review Board and was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science (20).

Protocol

Once informed consent was obtained, all participants were required to report to the institution's Human Performance Laboratory for the pre-and post-fitness assessment during week 1 and week 6. Body composition was assessed via the Tanita Body Composition Analyzer BF-350. A research assistant input sex and height information into the scale. Participants were asked to step on the scale with footwear, socks, and stockings removed. The results were displayed, and values were recorded on the data collection sheet.

Grip strength was assessed through the Lafayette Professional Hand Dynamometer (5030L1, Lafayette Instrument, USA). Participants were instructed to maintain the standard bipedal position, with both feet shoulder-width apart during the entire test with the arm in complete extension and not to touch any part of the body with the dynamometer except the hand being measured. Participants were instructed to comfortably grasp the handgrip dynamometer and were encouraged to exert a one-repetition maximal force. Three trials, with brief pauses, were allowed for each hand alternately. The sum of the highest (left) and (right) values was recorded on the data collection sheet.

The objective of the functional reach test was to quantify core stability. The functional reach test used a standard measuring stick affixed to the wall in a horizontal position at the height of the participant's acromion process. Participants were required to stand with both feet shoulder-width apart, close to the wall with their right shoulder 4-6 inches away from the wall. Participants were instructed to put the left arm to the side of the body and to put up the right arm forward horizontally (basic posture) and make a fist with the thumb inside. Participants were instructed to bend at the waist, lean forward, and reach as far as they can while keeping the fist at the same level as the measuring tape. Participants were also instructed to bend forward as much as possible without putting up a heel. A research assistant demonstrated the proper way to perform this assessment and served as a spotter during the assessment. Three trials were completed. The location of the third metacarpal head (right hand) was measured at the start and end distance for each trial. The (best trial) difference between the two values was recorded on the data collection sheet.

Overall balance was assessed with the NeuroCom Balance Master (Natus Medical Incorporated, Pleasanton, CA). Participants were fitted into a safety harness before stepping onto the NeuroCom Balance Master. A Sensory Organization Test (SOT) protocol comprised of six sensory conditions that identify abnormalities in the participant's use of the three systems that contribute to postural control: 1) somatosensory, 2) visual, and 3) vestibular was completed. During the assessment, inaccurate information is delivered to the patient's eyes, feet and joints through sway referencing of the visual surround and/or the support surface. The equilibrium score quantifies postural stability during each of the three trials of six sensory conditions. Per manufacturing guidelines, all participants were wearing safety harnesses while partaking in these balance tests to minimize the risk of injury.

The primary investigator was the instructor of the 6-week ST intervention. The key role for the instructor, during each class, was to introduce, reinforce, practice, and provide verbal corrective feedback for each ST exercise movement throughout the 6-week intervention (Table 1). Participants were required to attend 2 classes per week with each class being 50 minutes in duration, thus 12 total sessions throughout the 6-week intervention. Each class consisted of 8 ST exercises performed for at least one set with a second set administered as the 6-week ST intervention progressed. The decision to perform one versus two sets was based on the ability of the participant to become familiar with the ST exercises, the time needed for familiarization during the sessions, and the progression of intensity experienced by the participant. Thus, the instructor gauged these variables and determined when to implement a second set. Total amount of time for the ST exercises was 40 minutes allowing for 10 minutes to be utilized for the stretch/recovery exercises. The intervention was a group fitness class implemented within the fitness center of the retirement community. The fitness center was an ideal location chosen as it is on the grounds of the community and offer amenities such as music during sessions, mirrors for visual positional feedback during exercise, and provided an overall sense of community engagement for the participants. Attendances was recorded daily with a 100% participation for all sessions. One of the benefits to the participant for the utilization of suspension training is the amount of intensity experienced during an exercise bout. As the participant performs an exercise, they have the ability to control the intensity by way of position in relation to the anchoring point. Thus, the participant may position themselves closer in-line with the anchor point of the ST system thereby increasing the intensity experienced. This allowed the participant to control their own intensity and comfort of exercise. During each exercise bout of 45 seconds, approximately 15-20 repetitions were achieved at a variable intensity level dependent on the participants comfort level. Throughout the 6-week intervention, participants were encouraged to push their comfort level to the maximum they were able to sustain, within reason of their own acceptable perception of exertion. The result was an increase in angle of pull, increased repetition, and a general overall increase of intensity as the 6-week intervention progressed. It should be noted, the increase of intensity was in-part due to the intervention research team motivating the participants throughout the program. Thus, the instructor's knowledge of group fitness is of importance when implementing said training program to ensure safety and optimal progression for the population involved.

Table 1. Suspension Training (ST) Regime (twice per week for 12 weeks).

Exercise Name	Strap Length	Body Position to Anchor	Time / Sets
STX Rows	Fully Shorten	SF (Stand Facing)	45 sec/1 to 2
STX Squat – Row	Mid-Length	SF	45 sec/1 to 2
STX Bicep Curl	Mid-Length	SF	45 sec/1 to 2
STX Chest Press	Fully Lengthen	SFA (Stand Facing Away)	45 sec/1 to 2
STX Shoulder Extension	Fully Lengthen	SF	45 sec/1 to 2
STX Squat – Bicep Curl	Mid-Length	SF	45 sec/1 to 2
STX Triceps Extension	Fully Lengthen	SFA	45 sec/1 to 2
STX Squat – Row – Curl	Mid-Length	SF	45 sec/1 to 2
Cool Down Period	Strap Length	Body Position to Anchor	Hold Time
STX Pec Stretch	Fully Lengthen	SFA	20 sec
STX Low Back-Hip Hinge	Fully Lengthen	SFA	20 sec
STX IT-Band Stretch	Mid-Length	Stand Sideways	20 sec

Statistical Analysis

A paired sample *t*-test was used to examine differences from pre to post, with the *p*-value set at 0.05. Data were analyzed with Excel for the following variables: body mass (kg), body fat (%), grip strength (kg), functional reach (cm), and NeuroCom overall balance score. Effect size (ES) was calculated for variables that reached statistical significance using Cohen *d* to determine the magnitude of mean differences. A $d = 0.2$ is considered a small effect size, $d = 0.5$ is a medium effect size, and $d = 0.8$ a large effect size.

RESULTS

The primary aim of this study was to determine the efficacy of a 6-week ST exercise program amongst older adults. Eleven participants were recruited, and zero dropped out; therefore all 11 participants' results were included in the analyses (Table 2). Attendance was taken during the 6-week intervention with 100% compliance recorded. A paired sample *t*-test was used to determine differences from pre- and post-assessment. Improvements were as follows, functional reach (57.2 ± 6.4 vs 68.6 ± 4.3 cm; $p = 0.02$ and ES = 1.15) and overall balance score (67.5 ± 2.4 vs 72.2 ± 2.2; $p = 0.02$ and ES = 0.45). No statistical differences were observed in body fat, body mass, or grip strength. See table 3 for a detailed description of the findings.

Table 2. Descriptive data (mean ± SD) for male, female, and overall participants.

	Male (n = 3)	Females (n = 8)	Overall (n = 11)
Age (yrs)	83.7 ± 5.7	78.6 ± 4.2	80.0 ± 4.9
Height (cm)	176.5 ± 3.4	162.4 ± 8.0	166.3 ± 9.5
Body Mass (kg)	81.9 ± 23.6	67.2 ± 12.6	71.2 ± 16.4

Table 3. Pre- and post-fitness assessment (mean ± SE) amongst all participants.

	Pre-Assessment	Post-Assessment	Effect Size (d)
Body Fat (%)	34.2 ± 2.6	34.3 ± 2.8	0.01
Body Mass (kg)	71.2 ± 4.9	71.1 ± 4.9	< 0.01
Grip Strength (kg)	22.4 ± 1.9	22.8 ± 1.8	0.03
Functional Reach (cm)	22.5 ± 2.5	27.0 ± 1.7*	1.15
NeuroCom Balance Score	67.5 ± 2.4	72.2 ± 2.2*	0.45

* $p \leq 0.05$

Table 4. Pre- and post-fitness assessment (mean ± SE) amongst males.

	Pre-Assessment	Post-Assessment	Effect Size (d)
Body Fat (%)	27.2 ± 5.6	26.4 ± 6.6	0.08
Body Mass (kg)	81.9 ± 13.6	81.5 ± 14.0	0.01
Grip Strength (kg)	28.4 ± 8.5	28.0 ± 9.1	0.05
Functional Reach (cm)	18.4 ± 2.4	22.9 ± 2.2*	0.80
NeuroCom Balance Score	66.7 ± 5.2	72.3 ± 2.0	0.64

* $p \leq 0.05$

Table 5. Pre- and post-fitness assessment (mean ± SE) amongst females.

	Pre-Assessment	Post-Assessment	Effect Size (d)
Body Fat (%)	36.9 ± 2.5	37.2 ± 2.5	0.05
Body Mass (kg)	67.2 ± 4.4	67.3 ± 4.3	0.01
Grip Strength (kg)	20.1 ± 3.5	20.8 ± 3.7	0.05
Functional Reach (cm)	24.1 ± 1.0	28.6 ± 0.5	1.47
NeuroCom Balance Score	67.8 ± 2.9	72.1 ± 3.0	0.39

* $p \leq 0.05$

DISCUSSION

The literature is sparse concerning the effects of ST and older adults; therefore, the purpose of this investigation was to determine the effects of a 6-week ST program on the fitness components amongst a population of older adults. Researchers hypothesized the data will indicate a statistically significant improvement from pre- to post-assessment for all data-points evaluated.

The four fitness components assessed within the current study were: body composition, grip strength, functional reach capacity (i.e., core stability), and overall balance. Results of this study revealed the 6-week ST exercise program evoked large improvements in functional reach and moderate improvements in NeuroCom balance scores within the sample of older adults. Against this backdrop, the ensuing paragraphs will compare current findings with those from the literature.

A study conducted in 2015 by Gaedtke and Morat (10) sought to determine the feasibility of utilizing ST amongst older adults. These authors assessed seven modifiable exercises. For example, changing the body angle, grip position, and strap length could increase or decrease the intensity of the exercise. Results from the study displayed positive effects in gait, balance, and strength, and many participants wanted to continue ST training when the intervention terminated. Gaedtke and Morat (10) concluded that ST may be the more feasible and practical program for the older adult population due to the positive effects on the improvements in balance and strength. Findings from the current study supported said outcomes as well.

Results of the current study differed from the Boonsit, Peepathum, and Mitranun (1) study reviewed in the introduction. The current study included a full-body workout with an increased number of exercises compared to that of the Boonsit study. The authors of said study implemented three exercises and emphasized the physiological adaptations that occurred due to the prescribed exercises. The current study attempted to examine the balance and stability adaptations from the ST exercises prescribed.

As previously mentioned in the introduction, the Campa, Silva, and Toselli (3) study examined the effects of a 12-week suspension training exercise training program on handgrip strength and anthropometric measures including BMI, height, body weight, and bioelectrical impedance on 30 older adult women. The ST intervention was 12 weeks and included a 10-minute warm-up, 40 minutes of working out which included 6 exercises followed by 10 minutes of stretching. The current study was more closely aligned with the Campa study and provide a good comparison as to the results from each data set. Findings from said study revealed there were significant increases of phase angle, impedance vector displacement, and handgrip strength, with significant improvements in body fat percentage in the training group after the 12-week intervention period. Results of the current study differed from said study in that Campa, Silva, and Toselli's (3) research consisted of women participants. Specifically, the current study had both males and females in the study, thereby generalizing to a mixed population of older adults. In addition, the current study implemented a 6-week training program which is half the intervention training period of the Campa study. The decreased intervention training period may potentially explain why results from the current study did not accurately compare with the Campa study. For instance, grip strength and body fat percentage did not result in as significant changes as the Campa study. Nevertheless, the current study did identify improvements in balance following 6-weeks of a training program versus 12-weeks which may be helpful when designing a fall-prevention program for elderly population groups. The authors of this study recommend future studies implement a similar study as the one reviewed in this manuscript with the addition of 6 weeks to the training period to determine if the data set may result in similar statistical findings to that of the Campa, Silva, and Toselli's (3) research.

Lastly, in 2019, Jimenez-Garcia, Martinez-Amat, Torre-Cruz, Fabrega-Cuadros, Cruz-Diaz, Aibar-Almazan, Achalandabaso-Ochoa, Hita-Conteras (15) examined the effects of a 12-week high-intensity interval exercise ST program. Researchers measured muscle strength, body composition, gait speed, and quality of life in 82 older male and female adults before and after the 12-week suspension training intervention. Findings from the said study revealed the participants showed a high adherence to the exercise training programs and there were no significant changes in body composition, but there were significant changes in muscle strength, gait speed, and quality of life. Researchers concluded that an ST exercise program could be a good method to achieve improvements in the health of older adults. Results of the current study are similar in that there was a suspension training program implemented for older adults. The current study also revealed no significant changes in body composition but differed in the lack of assessments of gait speed and quality of life. Specifically, the current study used body composition, handgrip strength, functional reach test for core stability, and an overall balance assessment and saw improvements in functional reach and the overall balance test.

There were several limitations to this study that may have impacted the results. As stated above, findings from this study revealed changes in two of the four fitness components following the suspension training intervention, specifically, functional reach assessment and overall balance assessment, whereas body composition and upper body muscular strength did not reveal significant changes. No pre-visit instructions were given for the participants in terms of eating and hydration which could influence BIA body composition analysis. While the 6-week ST exercise program focused upon whole-body balance or proprioceptive training movements, the intention was also to elicit a low level anaerobic-based response, not aerobic-based. Additionally, researchers of the current study did not track participant's food intake during the 6-week program. Coupling the aforementioned together, the lack of difference between pre-and post-assessments for body composition may be due to the scarcity of data concerning caloric management. It should be noted, the program designed for this current study was not intended to elicit adaptations in muscular hypertrophy or muscular strength. As such, the lack of ultrastructural muscle damage and stress to metabolic systems associated with muscular strength may not result in the typical chronic resistance training adaptations experienced. In other words, given the sample of older adult population, the ST regime prescribed had an emphasis of muscular endurance and balance training which traditionally does not elicit enough caloric deficit often associated with remodeling of connective and muscular tissue from hypertrophy and strength training. Regarding the findings between the pre-and post-assessments for overall upper body muscular strength quantified via handgrip dynamometer, this may be due to the relatively short duration (i.e., 6 weeks) of the study. More precisely, 6 weeks may have been too brief of a period to reveal any hypertrophic gains, especially in older adults. In addition to the limitations, there was no true measure of muscular endurance during pre- and post-assessment. As such, the research team did not accurately assess whether the intervention resulted in true muscular endurance adaptations. Another limitation was the small sample size (n = 11), which may have mitigated the full expression of the results of this study. Participants in the current study were predominantly female (n = 8) compared to male (n = 3), thus, a larger sample size with more male participants would be recommended for any future studies.

In conclusion, the deleterious effects of aging are inevitable. Cardiorespiratory health, enhancing metabolic immunity, preventing various hypokinetic diseases, increased muscular fitness, mobility, and balance are essential attributes that define the quality of life. Thus, the intention of the intervention prescribed focused on the implementation of total body balance and proprioceptive body movements. As such, further research in the realm of ST and older adults is still needed as many of the attributes mentioned above have not been validated within this study. A key take-away from the current study revealed that only 12 ST sessions indicated a positive trend and improvements for core stability and proprioception resulting in the potential decrease of fall risk. Future research should validate the use of ST and fall risk prevention with a larger cohort of older adults and a longer intervention period. Engaging in physical activity and exercise are some of the many factors to mitigate the ill effects of aging and augment the quality of life. While the suspension training system is popular amongst young adults, research studies examining the effects of ST amongst older adults are limited. To that end, the purpose of this investigation was to add more data into the dearth of literature concerning ST and older adults, and to promote future research.

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