Original Research

Power Training and Functional Performance in Middle Aged Women: A Pilot Study

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ABSTRACT

International Journal of Exercise Science 9(3): 327-335, 2016. Muscular power is a key component of functional performance (FP) and fall risk reduction. The present study investigated the effect that power training with medicine balls had on body composition and FP in middle-age females. 10 women were divided into a control group (n=4, age=59.8±3.6) and an intervention group (n=6, age=59.5±3.6) in this 6-week study. The intervention group completed a medicine ball training program two times a week. Body composition and FP tests were administered pre-post. Data was analyzed using a series of Wilcoxon Signed Ranks test and Cohen's d test for effect size. The 6-week training program increased functional performance. The intervention group exhibited increases in the Up and Go test (p<.05) (Cohen's d=1.76), as well as maximum (p<.05) (Cohen's d=-1.52) and average (p<.05) (Cohen's d=-1.32) distance thrown on the seated medicine ball throw. Middle-aged females can experience significant improvements in functional abilities after 6 weeks of participation in a medicine ball training program that includes both resistance and power training.

KEY WORDS: Aging, body composition, medicine balls, fall risk

INTRODUCTION

There is typically an association between advancing age and reduction in functional abilities (6). A minimum amount of functioning is needed to stay independent; therefore, improving functional abilities is crucial to prolonged independence and safety in the older population (6). In 2011, it was estimated that approximately 36 million people in the United States were classified in the young old (65-74 years old) or older (75-84 years old) (6, 28). Nearly 4.5 million people were classified in the oldest old category (85+ years old) (6, 28). Sarcopenia and osteoporosis are comorbidities often associated with the aging process possibly leading to decreased physical capacity and increased risk of falling (1, 2, 24, 25, 29). Recently, it has been suggested that the onset of sarcopenia starts much earlier than expected, possibly before reaching middle age (55-64 years old) in women (16, 28). Approximately 21% of middle aged individuals have experienced a fall, suggesting that falling is experienced before reaching old age (32). The Center for Disease Control (CDC) estimates that one out of three older adults fall each year, and falls experienced by those 65 and older, ending in death, have risen 40% higher for men than women (3). This could possibly lead to inactivity, developing a fear of falling, leading to an increased fall risk (3, 4). Because of this trend, the American College of Sports Medicine (ACSM) developed guidelines to aid older adults in engaging in exercise, recommending that older adults should exercise at a moderate intensity 2-3 times a week for a total of 150 minutes a week (3). However, these guidelines may fall short of eliciting muscular adaptations that are specific to an older adult's life.

As the body ages, there is a reduction in the cross sectional area of muscle tissue (25). Type II muscle fibers are responsible for generating short bursts of strength however, the number of type II fibers decrease with age, which decreases muscle contraction velocity (25). This decrease may impact an individual's ability to perform activities of daily living and suggests that training methods should be focused on the enhancement of type II muscle fibers and increasing the rate of force production (8, 12).

Power training as a training method has been proposed as a possible way of counteracting the physiological declined experienced by aging. Studies examining the effect of power training exercise programs on middle aged adults, have reported increased hypertrophy and functional ability (9, 10, 24). These results suggest that explosive movements may be the key to prevent falls, because older adults may not possess the adequate amount of type II muscle fibers to stop or recover from a fall (2). The production of muscle power relies on the ability to develop high levels of force production at a high rate of speed, which is a key contributor to power expression and is more specific to the lives of older adults (5, 27, 29). Therefore, designing exercise programs using high velocity movements intended to elicit muscular power adaptations may be crucial to maintaining independence, prevent falling, or aid in recovering from a fall (2, 5).

Although, strength training has been shown to be a reliable method of improving strength in older adults, it may not be specific to the older adult's life (8, 18, 20, 22, 30, 31). Thus, strength training alone fails to meet the principle of specificity (23). There is a need for training programs aimed at enhancing power within this population that can be performed easily, safely and with minimal equipment. Therefore, the purpose of this study is to examine the effectiveness of a medicine ball exercise program on the development of power in middle-aged women. Considering that power training programs may improve functional performance in older adults, it was hypothesized that a medicine ball power training program will elicit functional performance improvements.

METHODS

Participants

Ten healthy, middle aged (55-64 years old) Caucasian women participated in the study. Four were assigned to the control group and six were randomly assigned to the intervention group. All ten participants completed all training sessions for the full duration of the study. A convenience sample from individuals within the community, who met the proposed age requirements, had not participated in an organized resistance-training program, exercises classes, or received training from a fitness professional for the previous six months were recruited for participation in this study. Participants were included in the study if they were able to rise from a chair while holding a medicine ball across the chest, and perform the back scratch test without pain. Individuals who were unable to accomplish either of these tests or felt pain were excluded from the study. Additional exclusion criteria included: lack of functional independence, severe cognitive impairment, uncontrolled hypertension, myocardial infarction, cerebrovascular incident, or had heart surgery in the last six months. If the individual met the inclusion criteria a Physical Activity Readiness Questionnaire (PAR-Q), initial health assessment, the short form of the International Physical Activity Questionnaire, and informed consent was obtained prior to the initiation of the study. The Ethics Committee approval was granted prior to the beginning of the study.

Protocol

The control group was asked to continue to engage in their normal activity habits during the six week duration of the study. As an incentive to participate in the study, the participants in the control group were provided a free week of medicine ball training at the conclusion of the study. Participants in the intervention group performed the medicine ball training program twice a week for the six week duration of the study. Participants were provided instructions about the program and familiarized with the upper body power and functional assessment tests with 3 practice trials prior to engaging in the study.

Prior to beginning the study, the participant's height (m), weight (kg), and body mass index (BMI) were assessed prior to the initiation of the study. A dual energy x-ray absorptiometry (DEXA) scan was used to determine body composition and bone mineral density (BMD) (whole body area BMD, lumbar spine (L1-L4), and right and left proximal femur).

A modified seated medicine ball throw (SMBT) adapted from the protocol set forth by Harris et al (11), was used in this study. Participants were instructed to sit in the chair with upright posture, and the feet in full contact with the ground in front of the chair. Participants were handed a medicine ball and were instructed to extend the arms while holding the medicine ball at chest level, at this point the tape measure was adjusted to account for different arm lengths (11). Participants were instructed to slowly pull the medicine ball to their chest and after a brief pause, explosively passed the medicine ball forward attempting to achieve as much distance as possible for each throw. Participants were given ample amount of time to familiarize themselves with the throwing procedure. After the familiarization period, they performed three maximal trials attempting to achieve maximal distance. Participants were provided with 15 seconds of rest in between attempts. If the participant's back came off of the back of the chair, then the attempt did not count and the participant would be given another attempt following sufficient rest time. The mean distance thrown of the three attempts were used for statistical analysis.

The timed up and go test (TUG) was utilized to measure general mobility and speed (14, 21). The starting position consisted of the participants sitting on a chair (chair height=45cm) with upright posture, feet placed flat on the ground, and arms crossed on their chest (14, 17, 21). Next, participants were instructed to rise from the chair, walk to, and around a cone (three meters) in front of them, walk back to the chair, and return to the starting position. Time started the moment the participant's back loses contact with the chair and concluding when the starting position was regained. Participants were allowed a familiarization period before actual testing began. One recorded unassisted test followed a one-minute rest period after the practice trial (17, 26).

The sit-to-stand test began with participants sitting in a straight-backed chair placed against a wall with upright posture, arms crossed, and feet flat on the floor. Participants were instructed to rise from the chair until they reach full height, without the use of their arms, and then return to the seated position. This action was performed as many times as possible for 30 seconds, recording the total completed repetitions (15, 24).

The medicine ball training program (MBTP) consisted of two sessions per week for six weeks (19, 33). The intervention group completed a three to five-minute dynamic warm-up prior to each workout. The MBTP consisted of five exercises each performed one to three sets of six to eight repetitions at the training load of 5% of the individual's body weight, moving the weight as rapidly as possible while maintaining good technique (24). The MBTP utilized in his study is displayed in Table 1. Training sessions lasted about one hour for two non-consecutive days 48-72 hours apart.

Table 1. Power Training Exercises and Progression

Exercises^	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Underhand Squat*#	1x6	1x8	2x6	2x8	3x6	3x8
Lateral MB Throw*#	1x6	1x8	2x6	2x8	3x6	3x8
Shoulder Press*#	1x6	1x8	2x6	2x8	3x6	3x8
Overhead Step and Throw*#	1x6	1x8	2x6	2x8	3x6	3x8
MB Sit Up*#	1x6	1x8	2x6	2x8	3x6	3x8

*Exercises are completed with an intensity of 5% of the individual's body weight
#Example: 1x6: one set of six repetitions.
^Rest periods are 2 minutes between sets and 3 minutes between exercises.

Statistical Analysis

Data was entered into a computer file suitable for statistical analysis using the SPSS 22.0 statistical program. Descriptive statistical analyses were used to examine the mean and standard deviations for the whole sample. Differences in mean scores were determined by a series of Wilcoxon signed rank tests. An effect size test was conducted to demonstrate the relative magnitude of difference between each group. The classifications for the effect size were determined using Cohen's d (0.2 = small, 0.5 = medium, 0.8 = large). Significance level was set at $p<0.05$.

RESULTS

There were no significant differences between groups for any of the performance measures for the pre-test session. Collectively, participants completed 100% of the assigned training sessions. Demographic information for these two groups is displayed in Table 2.

Table 2. Population Demographics per group

	n	Height (in)	Weight (kg)	Age (yrs)	BMI	BF%	Bone Mineral Density *	Lean Mass (kg)	Fat Mass (kg)
Control Group	4	64.9+2.88	79.6+6.5	59.8+3.6	28.7+4.3	36.8+9.0	1.1+0.1	46.9+28.55	27.67+16.2
Intervention Group	6	61.8+2.0	70.3+20.3	59.5+3.6	28.1+10.3	37.7+12.0	1.1+0.1	40.6+49.6	27.98+86.7

*=Data described as means and standard deviations

No significant changes in anthropometrics, BMD, or body composition were found in either group at the conclusion of the study (Table 3).

Table 3. Pre and Post-test Performance Measures per Group

Groups	The Up & Go	Sit to Stand	Average Distance Thrown
Control Group Pre-Test	6.4+1.6	16.8+8.1	8.3+2.9
Control Group Post-Test	6.0+1.3	25+9.0	9.9+2.2
Intervention Group Pre-test	5.9+0.7	18.7+5.2	8.2+1.1
Intervention Group Post-Test	4.9+0.4*	24+5.2^	10+1.2*

*=Statistical significant p<0.05

^= Trending toward statistical significance p≥0.06

However, there were significant differences for the intervention group in the TUG test (p<0.05) (r=0.659) (Cohen's d =1.756) average distance thrown (p<0.05) (r=-0.606) (Cohen's d=-1.52) and the maximum distance thrown (p<0.05) (r=-0.552) (Cohen's d=-1.32) on the SMBT (Table 3). While there were no significant changes in the Sit to Stand test performance within the intervention group, the data did reveal a trending toward significance (p= 0.06) (r=-0.455) (Cohen's d=-1.02) (Table 4).

Table 4. Pre and Post-test Performance Measures per Group

Groups	The Up and Go	Sit to Stand	Average Distance Thrown
Control Group Pre-Test	6.4+1.6	16.8+8.1	8.3+2.9
Control Group Post-Test	6.0+1.3	25+9.0	9.9+2.2
Intervention Group Pre-test	5.9+.7	18.7+5.2	8.2+1.1
Intervention Group Post-Test	4.9+.4*	24+5.2^	10+1.2*

*=Statistical significant p<.05

^= Trending toward statistical significance p≥.06

DISCUSSION

The purpose of this study was to examine the effects of a medicine ball exercise program on the development of power in a middle-aged adult population. To the researcher's knowledge this is the first study conducted to examine the effects of such a program amongst individuals in this population. Significant findings in the TUG, and average distance thrown were evident even with a low number of participants and short study duration. These findings suggest that a six-week MBTP may be an effective means of improving upper body power and functional abilities in middle-aged females.

Possibly, the most interesting results of the study was the significant improvement in the intervention group's time to complete the TUG test compared to the control group. Participants in the intervention group were able to complete this test significantly faster after performing the six-week MBTP when compared to the control group. These results are consistent with research conducted by Pereira et al. (24) that found high-speed power training improved functional performance and power in older women on TUG and the SMBT after completing only a six-week training program. The improvement, observed in the study, may be explained by the emphasis on utilizing exercises performed in a standing position that required participants to balance and stabilize their bodies while producing force, such as the deadlift and overhead throw exercise. Therefore, exercises that require an individual to produce, reduce, and stabilize force, preferably from a standing position, may have a greater transfer of training effect to functional activities than those performed in a seated position. This may be due to the reduced need for stability and balance when seated.

While not statistically significant there was a trending toward significance in the Sit to Stand test performance in the intervention group compared to the control group. These results are similar to those of Henwood and Taaffe (13) who saw an increase in the chair rise test after completing a high velocity training program. In a 16 week study by Fahlman et al. (6) the intervention group showed significant increases in the sit to stand test after completing a resistance band exercise program. Results from our study may suggest that the MBTP may have had a positive influence on lower-body strength and power in a shorter time period. This could be due to the medicine ball dead lift exercise, since this movement involves many of the same muscles that allow an individual rise from a chair.

Results also indicated that there were significant improvements in the average distance thrown for the SMBT after completing the 6 week training program. Participants who completed the training program showed a significant improvement in the average distance thrown from the pre- to post-test (22.9 %) when compared to the control group (19.3 %). This suggests the medicine ball training program had a greater impact on upper body power in the intervention group. Curiously, while there was a substantial non-statistically significant improvement in performance of this measure within the control group, based on the large standard deviations seen in this group it is likely these averages were influenced by extreme scores. The findings are consistent with Pereira et al. (24) who found increased upper body power in older adults after a 12 week medicine ball training program. Pereira et al. (24) study included bench press and a medicine ball throw exercise, their participant's improvements could be explained by a learning effect. Our results are also congruent with Faigenbaum and Mediate's (7) study examining fitness performance in high school students on a medicine ball throw. The training protocol in this study utilized a wall chest pass suggesting the participants may be subject to a learning effect (6). In the present study, in the MBTP the medicine ball chest throw for distance was not included as an exercise in order to ameliorate any improvements in performance that could be explained by a learning effect. Therefore, this increase in performance may be due to the upper-body exercises that improved strength in the shoulders and triceps muscles (e.g., shoulder press) utilized in this study. These results are consistent with other studies that utilized longer intervention periods (22, 24).

Based on these results it appears that middle-aged females can experience significant improvements in functional abilities after as little as 6 weeks of participation in a medicine ball training program that includes both resistance and power training. This is significant because the training program utilized can be performed almost anywhere with minimal time, space and equipment requirements. The novelty of this study has produced similar results to Pereira et al. (24), but in half of the time. These findings add to our understanding of potentially effective training modalities and methods for developing power and functional performance amongst middle-aged females. Medicine balls can be easily used for different movement patterns that mimic everyday activity and can elicit improvements in whole body power. This simple piece of equipment is also cost effective and could be more available to older people than a weight room. Medicine balls may be an exercise modality that can sufficiently meet the requirements of the principle of specificity.

One limitation of the study was there was a small sample size. This could have affected the level of significance for the sit to stand test. In the future, increasing the sample size in the study could provide more generalizable and significant findings. Another limitation was the length of time between training sessions. This could have affected the body composition results. One recommendation for future research should focus on increasing the intervention protocol to an 8 week duration, this could show an increase in training outcomes. Another recommendation for future research should examine if increasing the training sessions to three times a week would increase development of lean tissue.

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