EFFECT OF FUNCTIONAL RESISTANCE TRAINING ON MUSCULAR FITNESS OUTCOMES IN YOUNG ADULTS

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As functional resistance training becomes a more popular method to improve muscular fitness, questions remain regarding the effectiveness of functional training compared to traditional resistance training. Therefore, the purpose of this study was to determine whether functional training has similar effects as traditional resistance training on muscular strength and endurance, flexibility, agility, balance, and anthropometric measures in young adults. In this study, 38 healthy volunteers, aged 18–32 years, were randomly placed into a control group [traditional ($n = 19$)] and an experimental group [functional ($n = 19$)]. The participants were tested prior to and after completing the 7-week training study. The testing battery included: weight, girth measurements, flexibility, agility, lower back flexion and extension endurance, push-up test, sit-up test, one-leg balance, one-repetition maximum (1-RM) bench press and squat. Results indicated significant ($p < 0.05$) increases in push-ups, back extension endurance, 1-RM bench press, 1-RM squat, and one-leg balance within each group following training. Traditional training also elicited significant ($p < 0.05$) increases in bicep girth, forearm girth, calf girth, and sit-ups, while the functional training group experienced significant ($p < 0.05$) increases in shoulder girth and flexibility. Forearm girth and flexion test time changes following training were the only parameter where there were significant ($p < 0.05$) differences between training groups. Collectively, these results suggest that both programs are equally beneficial for increasing endurance, balance, and traditional measures of strength. However, changes in various girth measures, torso flexor endurance and flexibility appear to be program-specific. [*J Exerc Sci Fit* • Vol 8 • No 2 • 113–122 • 2010]

Keywords: activities of daily living, exercise movement techniques, multi-joint exercises, muscular flexibility, strength training

Introduction

Functional training is becoming increasingly popular within the fitness industry and has been considered to be a better alternative than traditional resistance training for improving various measures of muscular fitness including strength, endurance, coordination and balance. Definitions describing what functional training is or what a functional exercise program should entail vary considerably in the literature. Furthermore, experimental research conducted to ascertain the muscular fitness benefits of functional training is limited and focused specifically on improving function in older adults (Milton et al. 2008; de Vreede et al. 2005; Whitehurst et al. 2005).

The verb form of the word "function" pertains to the performance of an action, work or activity. Thus, exercise training programs that are deemed to be "functional" should be designed to mimic tasks or activities that occur in a person's daily life to make training adaptations more transferable. Rikli and Jones (1999) define functional fitness as having the ability to

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safely and independently complete activities of daily living without undue fatigue. Functional fitness has been defined by Brill (2008) as emphasizing multiple muscle and joint activities, combining upper body and lower body movements, and utilizing more of the body in each movement. This philosophy espouses the thought that functional exercise programs should be designed to improve movement and include movement-based exercises versus focusing solely on specific muscular adaptations in isolation (traditional view). Other authors describe functional training as being beneficial because all natural movements occur in multiple joints through multiple planes of motion rather than in isolation (Lagally et al. 2009; McGill et al. 2009; Stone et al. 2007). Cosio-Lima and colleagues (2003) describe functional training as the ability of the neuromuscular system to stabilize the body through dynamic and isometric contractions in response to stressors such as gravity, ground reaction forces and momentum. Considering the principle of specificity, training that replicates natural daily movements may be the most effective method at improving muscular fitness.

Traditional exercise programs are commonly thought to involve exercises that isolate specific muscles in order to increase strength more effectively (McGill et al. 2009). Applying this philosophy, the focus of a traditional exercise program is to increase the strength or endurance of a particular muscle or muscle group without regard to training movements that are related to activities of daily living or sport performance. Traditional, machine-based and free weight exercise programs that restrict movement along one plane of motion (usually sagittal) may elicit poorer carry-over effects to real life activities that occur in multiple planes (Whitehurst et al. 2005). Past research has demonstrated a similar or, in some cases, greater improvement in overall muscular function in young and older adults following functional versus traditional training programs (Kibele & Behm 2009; de Vreede et al. 2005). In contrast, other research on traditional forms of resistance training has shown that properly designed programs have multiple benefits, including increasing quality of life and reducing disability in people with and without cardiovascular disease (Williams et al. 2007). Identifying the differences between functional- and traditional-based programs may allow further understanding of the role resistance training plays in maintaining physical health and other fitness benefits.

A study by de Vreede and colleagues (2005) involving a group of elderly women demonstrated that functional task exercises were more effective than resistance exercises at improving functional task performance. These results suggested that functional task exercises play an important role in maintaining an independent lifestyle. Participant adherence has also been shown to diminish for those using traditional-based programs because adaptations are less transferable to daily life situations, whereas functional programs resembling daily tasks may lead to enhanced levels of adherence (Williams et al. 2007). Milton and colleagues (2008) found that functional exercise training can improve fitness levels of older adults. The goal of maintaining independence becomes increasingly important for the aging adult; thus, creating exercise programs that improve functional fitness and contribute to prolonged independent living is a critical task.

There remains a need in the literature for additional studies focusing on functional exercise training and performance outcomes in younger adults. Recently, Lagally and colleagues (2009) studied the acute physiologic and metabolic responses to functional training in younger adults (19–27 years) and found that the exercise program performed elicited caloric expenditure levels that were associated with maintaining health according to the American College of Sports Medicine (ACSM). More research is needed utilizing this type of training beyond characterizing the physiologic and metabolic responses to functional training. Considering past research in older adults, it is plausible that gains in muscular fitness, flexibility and balance may also occur in younger individuals who participate in a functional training program; however, these findings remain to be elucidated. Therefore, the purpose of this study was to determine whether or not functional training has similar effects on muscular strength and endurance, flexibility, agility, balance and anthropometric measures in young adults as traditional resistance training. It is hypothesized that functional training will improve anthropometric and performance measures more effectively than traditional resistance training.

Methods

Participants

Thirty-eight men and women, aged 18–32 years, were recruited across the university campus and surrounding community through flyers and word of mouth to participate in the study during the Fall of 2008. All study participants were familiar with resistance exercise and were characterized as low to moderate risk according to ACSM risk stratification (ACSM 2006). Participants were excluded based on current precipitating injury, high risk stratification, or if they were currently in a structured resistance training program. Each participant signed a written informed consent form before beginning the study and the University Human Subjects Institutional Review Board approved all testing and training protocols. Five participants dropped out or were removed from the study for failing to follow the study protocol.

Experimental design and assessment of outcome variables

Participants were randomly assigned to either a functional or traditional (control) resistance training group and were assessed before and after the 7-week training period using identical testing protocols. Individual participant testing sessions were performed at the university's Exercise Physiology Laboratory and completed within 1 hour. The tests included measurements of body composition, muscular strength and endurance, flexibility, agility and balance. Participants were instructed to follow specific pretesting guidelines: dressed in workout attire, refraining from vigorous exercise and alcohol consumption 24 hours prior to testing, and coming properly hydrated. All participants were instructed to perform each test to maximal effort and verbal encouragement was provided throughout each test. All participants were tested in a specific order so as to standardize the testing process: weight, height, body composition, flexibility, muscular endurance, balance, agility and muscular strength.

Standardized procedures were followed for each of the assessment tests and are published in detail elsewhere. Muscular strength was assessed via a one-repetition maximum (1-RM) bench press and squat test (Logan et al. 2000). Flexibility was assessed using a modified sit-and-reach test and the best of three results was recorded to the nearest 0.1 cm as the final value (Canadian Society for Exercise Physiology 2003). Muscular endurance was evaluated using a push-up test, curl-up test, timed flexion test, and timed extension test (McGill 2004; Canadian Society for Exercise Physiology 2003). The timed flexion and extension time was recorded to the nearest 0.01 seconds. Agility was assessed using the pro-agility shuttle run and timed manually using a handheld stopwatch and recorded to the nearest 0.01 seconds (NSCA 2008). Balance was assessed using a single leg half squat measured on both right and left sides of the body (ACSM 2007). Subjects were instructed to bend their knee to approximately 60° of flexion while maintaining proper position throughout each repetition. The test was terminated when the subject lost proper positioning due to loss of balance. Body composition was evaluated via standardized procedures (ACSM 2006) for girth measurements of the shoulder, bicep, forearm, umbilicus, thigh and calf using an inelastic tape measure with a Gulick spring-loaded handle (Gulick II Measuring Tape; Country Technology Inc., Gays Mills, WI, USA). All girth measurements were recorded to the nearest 0.1 cm.

Training guidelines

All participants performed the training program at the university's Strength and Performance Center. Participants were divided and assigned to an individual researcher in order to provide closer supervision and monitoring of training progress. After pretesting, each participant participated in a one-on-one orientation to their specific program. During this orientation period, participants were given a training log as well as a reference packet illustrating and describing each exercise. Exercises were explained and demonstrated to the participant and then the participant was required to perform each exercise to check for technique issues and address questions.

Two sets of 10 repetitions at a moderate intensity of 6–7 on the modified Borg rating of perceived exertion (RPE) scale (Borg 1982) were completed for each lift and rated according to guidelines published by Sweet et al. (2004). Exercise sessions were completed 3 days a week for 7 weeks. Each participant was required to meet with their individual researcher once a week in order to closely monitor adherence to the program, clarify questions, ensure proper technique for each exercise, and give specific information on progression. Resistance was progressed weekly by 5% of total weight lifted for the upper body and 10% for lower-body exercises so that the session RPE of 6–7 was maintained across the training program. The RPE was monitored during these progressions and if an exercise was rated above a 7, the weight was decreased to elicit a 6 or 7 rating. For exercises that did not include a weighted resistance (e.g. stability ball push-up, sit-up, side plank, stability ball hamstring curl), the volume of each exercise in the form of repetitions was increased by 10% to maintain an RPE rating of 6 or 7, which was measured at the conclusion of the exercise.

Participants were required to attend a minimum of 18 of the 21 training sessions. Participants could not train over 2 consecutive days and only two sessions could be missed in a given week. If participants did not adhere to these guidelines, they were immediately dropped from the study.

Traditional training program exercises

The traditional training program consisted of single- and multi-joint exercises completed using machine and free weight modalities. The majority of the exercises were performed in a seated, supine, or prone position. The following traditional exercises were performed: bench press, shoulder press (machine), lateral pulldown (machine), seated row (machine), bicep curl with E-Z curl bar, tricep pushdown (machine), seated leg press, seated leg extension, prone lying leg curl, standing calf raise (machine), and sit-up (arms crossed over chest and bringing elbows to thighs). A visual depiction of the majority of these exercises can be seen in Figure 1.

The major muscles or muscle groups that the traditional exercises involved were the pectoralis major (bench press), triceps brachii (bench press, shoulder press, tricep pushdown), biceps brachii (lateral pulldown, seated row, bicep curl), anterior deltoid (bench press, shoulder press), trapezius (lateral pulldown), posterior deltoid (seated row), latissimus dorsi (lateral pulldown, seated row), rhomboids (lateral pulldown, seated row), quadricep group (seated leg press, seated leg extension), hamstring group (seated leg press, lying leg curl), gluteus maximus (leg press), gastrocnemius (standing calf raise), and rectus abdominis and obliques (sit-up).

Functional training program exercises

The functional training program consisted of multi-joint/multiplanar exercises completed using free weight and machine modalities. The machine modalities that were used allowed for free motion during the exercise and therefore range of motion was not limited to a specific arc. The following functional exercises were performed: modified pull-up, modified dip, stability ball chest press, stability ball push-up, stability ball hamstring curl, multidirectional lunge, step up with toe press, squat (progressed from stability ball squat), one-arm cable row, cable twist, front and side plank. A visual depiction of the majority of these exercises can be seen in Figure 2.

The major muscles or muscle groups that the functional exercises involved were the pectoralis major

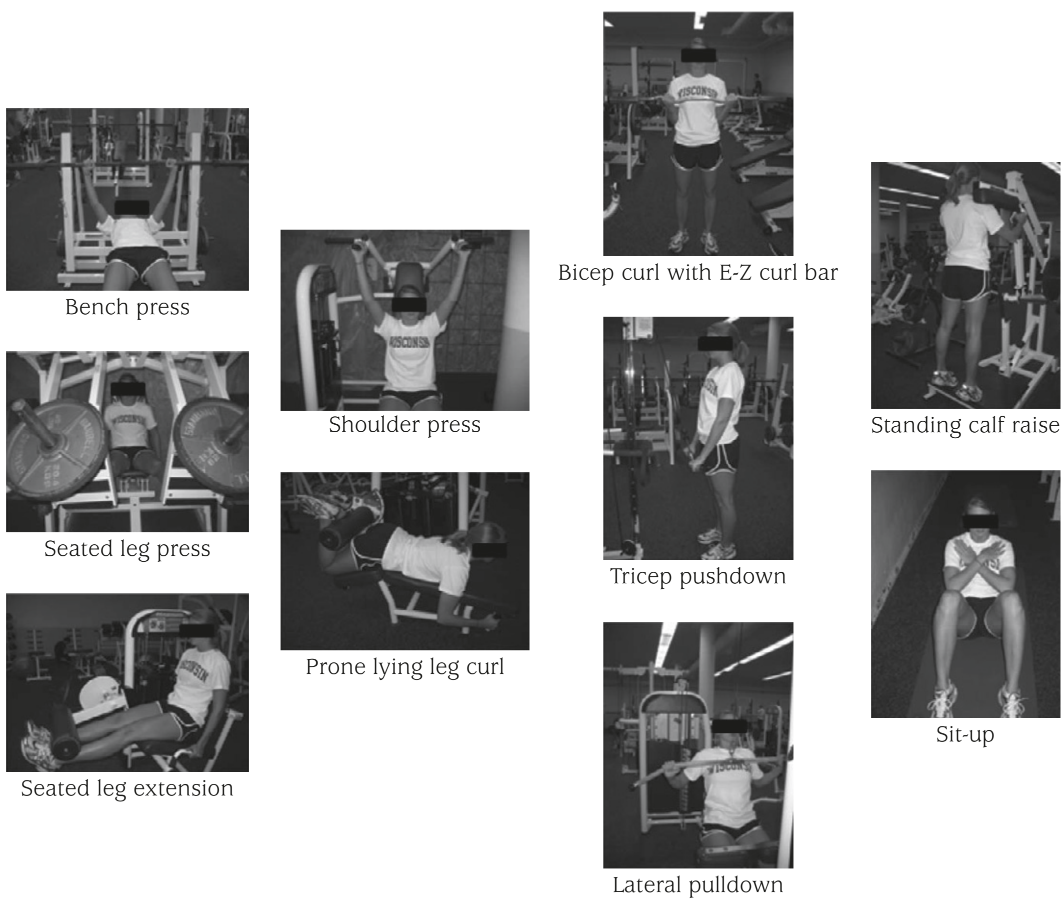

Fig. 1 Traditional exercises.

Fig. 2 Functional exercises.

(stability ball chest press, modified dip, stability ball push-up), triceps brachii (stability ball chest press, modified dip), biceps brachii (modified pull-up, one-arm cable row), anterior deltoid (stability ball chest press, modified dip), posterior deltoid (one-arm cable row), latissimus dorsi (modified pull-up, one-arm cable row), rhomboids (modified pull-up, modified dip, one-arm cable row), quadricep group (multidirectional lunge, step up, squat), hamstring group (stability ball hamstring curl, multidirectional lunge, step up, squat), gluteus maximus (multidirectional lunge, step up, squat), gastrocnemius (step up with toe press), and anterior, lateral and posterior core muscle groups (chest press—for whole body stabilization, front and side plank, stability ball push-up—for whole body stabilization, stability ball hamstring curl—for whole body stabilization, cable twist).

Statistical analysis

Descriptive statistics were used to determine the mean, standard deviation, and mean percent change for each of the baseline tests. Independent *t* tests were employed to determine differences in the percent change between the functional and traditional exercise groups. Dependent *t* tests were utilized to determine pre–post differences within each group. Alpha level was set at $p < 0.05$ to determine statistical significance. SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) was used to analyze all data.

Results

Tables 1 and 2 summarize and present the data from all the outcome measures that were tested in the current study and are divided by training group. Table 1 shows all of the anthropometric variables tested in the study and Table 2 presents all the strength, endurance, balance, agility and flexibility outcome variables. Between-group comparisons revealed a significantly ($p < 0.05$) greater mean percent change for forearm girth in the traditional group and flexion test time in the functional group following the training program (Table 1). The forearm girth difference could be attributed to the inclusion of the bicep curl exercise in the traditional program that resulted in a specific adaptation in the forearm area. The flexion time improvement in the functional group could have been due to the inclusion of exercises that more effectively challenged the torso flexors. No other significant between-group differences were observed in the remaining study measures.

However, within-group comparisons revealed significant changes from pre- to post-training in the outcome

Table 1. Anthropometric measurements of the 33 study participants*

Variable	n	Pre-training	Post-training	% change
Weight (kg)				
Functional group	16	69.98 ± 17.09	70.53 ± 17.33	0.78 ± 2.11
Traditional group	17	74.39 ± 14.81	75.76 ± 15.57†	1.70 ± 1.94
BMI $[kg \cdot (m^2)^{-1}]$				
Functional group	16	23.78 ± 3.54	23.99 ± 3.62	0.84 ± 2.12
Traditional group	17	25.48 ± 3.88	25.52 ± 4.22	−0.08 ± 3.20
Shoulder girth (cm)				
Functional group	16	102.38 ± 9.08	104.09 ± 9.42†	1.62 ± 2.29
Traditional group	17	106.35 ± 8.87	107.64 ± 9.25	1.15 ± 2.46
Bicep girth (cm)				
Functional group	16	28.84 ± 3.31	29.41 ± 3.49	1.83 ± 3.80
Traditional group	17	30.18 ± 3.74	31.01 ± 3.87†	2.66 ± 2.67
Forearm girth (cm)				
Functional group	16	24.06 ± 2.27	24.31 ± 2.34	0.99 ± 2.63
Traditional group	17	24.74 ± 2.56	25.74 ± 3.09†	3.66 ± 4.19‡
Umbilicus girth (cm)				
Functional group	16	85.55 ± 10.38	84.31 ± 11.12	−1.63 ± 3.45
Traditional group	17	86.06 ± 10.65	85.28 ± 12.48	−1.28 ± 4.08
Thigh girth (cm)				
Functional group	16	50.81 ± 4.99	51.19 ± 5.02	0.68 ± 3.65
Traditional group	17	53.09 ± 6.04	53.34 ± 6.46	0.33 ± 3.83
Calf girth (cm)				
Functional group	16	36.88 ± 3.09	37.16 ± 3.00	0.76 ± 1.86
Traditional group	17	37.50 ± 3.71	38.19 ± 4.09†	1.71 ± 1.67

*Data presented as mean ± standard deviation; †post-training value significantly ($p < 0.05$) greater than pre-training within group; ‡percent change significantly ($p < 0.05$) greater in traditional *vs.* functional training.

variables (Tables 1 and 2). The functional group demonstrated significant ($p < 0.05$) mean differences (in parentheses) for: shoulder girth (1.71), push-up (12.43), extension (16.94), 1-RM bench press (7.96), 1-RM squat (18.53), flexibility via modified sit-and-reach (4.91), right leg balance (9.44), and left leg balance (10.87) tests. The traditional training program also elicited significant ($p < 0.05$) mean differences from pre- to post-training for: body weight (1.37), bicep girth (0.83), forearm girth (1.0), calf girth (0.69), push-up (10.53), curl-up (43.12), extension (16.94), 1-RM bench press (9.35), 1-RM squat (17.47), right leg balance (7.23) and left leg balance (7.77) tests. It should be noted that only the data from 28 participants were analyzed for the 1-RM squat measurement due to poor technique during testing in five participants.

Discussion

The purpose of this study was to determine whether or not functional training has similar effects as traditional resistance training on measures of muscular strength and endurance, flexibility, agility, balance and anthropometry in young adults with prior resistance training experience. The hypothesis that functional training would improve anthropometric and performance measures more effectively than traditional resistance training was not fully supported by the current data. Kibele and Behm (2009) found similar results in a 7-week functional exercise program in that strength and other functional measures (e.g. dynamic balance, shuttle run) were not different compared to a more traditional resistance exercise program.

The results from the current study identified specific improvements over time in the majority of the performance variables and some anthropometric variables for both the functional and traditional training groups. The only significant differences found between the training groups was a larger forearm girth in the traditional group and greater flexion test time in the functional group. As stated briefly in the results, the forearm girth change could be attributed to the inclusion of the bicep curl exercise in the traditional program that led

Table 2. Endurance, strength, flexibility, agility and balance values for the 33 study participants*

Variable	*n*	Pre-training	Post-training	% change
Push-up (repetitions)				
Functional group	16	16.63 ± 4.75	29.06 ± 6.82†	42.48 ± 11.77
Traditional group	17	20.88 ± 8.43	31.41 ± 8.42†	34.80 ± 15.62
Curl-up (repetitions)				
Functional group	16	54.38 ± 40.37	71.38 ± 44.13	23.8 ± 78.12
Traditional group	17	66.53 ± 93.39	109.65 ± 127.67†	38.27 ± 27.62
Flexion test (s)				
Functional group	16	98.13 ± 57.06	112.13 ± 53.47	6.82 ± 39.96‡
Traditional group	17	149.00 ± 108.26	126.82 ± 102.24	−36.24 ± 96.73
Extension test (s)				
Functional group	16	108.75 ± 36.56	125.69 ± 44.04†	9.13 ± 27.82
Traditional group	17	123.35 ± 62.99	140.29 ± 51.21†	12.17 ± 23.11
1-RM bench press (kg)				
Functional group	16	38.49 ± 11.90	46.45 ± 16.56†	16.07 ± 8.82
Traditional group	17	48.40 ± 17.21	57.35 ± 21.91†	14.49 ± 9.41
1-RM squat (kg)				
Functional group	12	50.57 ± 16.30	69.01 ± 14.17†	23.40 ± 7.03
Traditional group	16	62.22 ± 26.49	79.69 ± 25.77†	23.59 ± 13.11
Flexibility (cm)				
Functional group	16	35.31 ± 6.98	42.22 ± 5.44†	12.42 ± 13.32
Traditional group	17	38.41 ± 6.59	40.59 ± 5.31	4.33 ± 17.30
Agility (s)				
Functional group	16	5.73 ± 0.33	5.65 ± 0.31	−1.59 ± 5.24
Traditional group	17	5.49 ± 0.39	5.42 ± 0.29	−1.28 ± 4.96
Left leg balance (repetitions)				
Functional group	16	15.94 ± 12.29	26.81 ± 8.83†	42.43 ± 30.32
Traditional group	17	16.29 ± 10.15	24.06 ± 11.04†	31.19 ± 25.00
Right leg balance (repetitions)				
Functional group	16	17.06 ± 14.07	26.50 ± 13.11†	28.38 ± 56.10
Traditional group	17	16.06 ± 9.00	23.29 ± 12.48†	24.19 ± 34.44

*Data presented as mean ± standard deviation; †post-training value significantly ($p < 0.05$) greater than pre-training within group; ‡percent change significantly ($p < 0.05$) greater in functional *vs.* traditional training. 1-RM = one-repetition maximum.

to a specific adaptation in the forearm area. No exercise within the functional group mimicked this type of movement; thus, training specificity is the likely cause of this between-group difference. The modified pull-up is the only exercise within the functional group that specifically worked the upper arm in this fashion, but it was not as effective at eliciting the change seen in the forearm musculature within the traditional group.

The flexion test time improvement in the functional group could have been due to inclusion of exercises that more effectively challenged the torso flexors/anterior stabilizers of the spine such as the rectus abdominis. The flexion test was originally designed to challenge the endurance of the rectus abdominis and discriminates best on endurance improvements rather than strength (McGill 2004). Therefore, the mix of exercises within the functional training group was much more effective at improving endurance and produced better trained torso flexor muscles versus the traditional training group. In addition, flexion test time data showed that the traditional group actually decreased their time (~149 seconds *vs.* 126 seconds pre- and posttesting), indicating a loss of abdominal muscular endurance throughout the training period. According to a study by Pintar and colleagues (2009), traditional abdominal exercises, like the bent leg sit-up and other variations, do not improve muscular fitness outcomes in the abdominal region in healthy young adults. As such, inclusion of the traditional sit-up exercise in the current study did not result in better functional endurance (that evaluated by the flexion test) of the rectus abdominis and other torso flexors, which may result in poorer outcomes related to future low back health for instance (McGill 2004). However, while the lack of between-group differences does not support the original hypothesis, the data do show that functional training was as effective as traditional training in improving traditional measures of muscular strength and endurance.

The current study demonstrated that within a younger adult population, both functional and traditional resistance training programs can lead to similar benefits in basic fitness components. Both functional and traditional programs demonstrated improvements in the number of push-ups completed, extension test time, 1-RM bench press and squat, and left and right leg balance. Kibele and Behm (2009) also reported similar benefits from both types of programs in dynamic balance and 1-RM squat, but not for their agility measure, which was also a similar finding to the current study. In addition, although upper body strength testing was performed using a bench press test on a stable surface, the functional group saw improvements in strength performing the bench press exercise on an unstable surface (stability ball). Past studies have shown that adding an unstable surface to an exercise can decrease force output, thus potentially lowering the training stimulus and muscular adaptations over time (Drinkwater et al. 2007; McBride et al. 2006; Anderson & Behm 2005). However, Behm and colleagues (2002) suggested that if the instability challenge introduced during the exercise occurs at a moderate level (such as the stability ball in the current study), force production and training adaptations are not hindered. Even though it was not statistically different, the functional training group showed a slightly greater improvement in 1-RM bench press versus the traditional group (Table 2).

An improvement in extension test time was not expected in the traditional group since no exercise was included that specifically targeted low back musculature. The inclusion of pulling exercises such as lateral pull-down and seated row may have required a greater muscle activation to stabilize the trunk during a seated position than previously thought in order to perform these exercises with proper technique. Fenwick et al. (2009) demonstrated significantly increased muscle activation in the torso during single and double arm rowing exercises. The single arm rowing exercise was used in the current study as a functional exercise and likely contributed to improved back extensor endurance following the training program. Although the rowing exercise used by Fenwick et al. (2009) was a standing bent over row, it is plausible that some benefit was gained in the traditional group from seated rowing due to a small amount of postural challenge to maintain proper technique during the exercise. In addition, dynamic balance was also enhanced in both groups with the functional group showing a greater percent change following training, possibly due to the inclusion of more exercises that involved an upright posture as seen in other studies utilizing functional movements (Whitehurst et al. 2005). Thus, although traditional means of improving lower body strength (leg press, prone leg curl, seated leg extension) are still potentially useful at improving balance, functional means may be more effective.

Other unique changes worth noting that were observed in the traditional group were improvements on the number of curl-ups completed and increased girth measurements for the bicep, forearm, and calf following training. The curl-up results were likely enhanced by the specific inclusion of sit-up exercises in the traditional program and the training effect carrying over to the curl-up testing procedures. It also appears that the exercises included in the traditional training group (more isolational in nature) and the volume and intensity chosen were effective at producing some muscle hypertrophy in the areas measured. Thus, compared to more functional forms of exercise that only elicited increases in shoulder girth, traditional exercises may be more effective if the specific goal is to enhance muscle hypertrophy.

A unique change also worth noting within the functional group was improved performance on the modified sit-and-reach flexibility test following training. Flexibility is popularly believed to diminish with a regular resistance training program. Our data indicated that a mix of multi-joint exercises, especially those that involve the hip joint and movement in multiple planes, can maintain or possibly enhance flexibility in that region. Whitehurst and colleagues (2005) found similar improvements in sit-and-reach flexibility following a functional training program in older adults. In combination, the functional exercises in this study involved movement of the lower limbs in multiple directions. These participants also demonstrated an improvement in balance, which was also observed in the current study for both functional and traditional training groups. Since the modified sit-and-reach test is very specific to the hip region, we cannot offer any conclusions using the current data on the potential effects of functional training on other joints in the body. Additional research should be focused upon measuring range of motion at multiple joints and the effect that functional training may have on improvements in total body joint range of motion.

The improvements within the functional training group were also in agreement with other previous training studies. de Vreede et al. (2005) found that lower body strength, balance, coordination, and overall functional task performance were improved after a 12-week functional resistance program. Although strength was more enhanced by traditional resistance exercises, the older adult participants in their study were able to maintain task performance gains 6 months post-program. This was attributed to greater specificity of training within the functional exercise group. Milton and colleagues (2008) also found that after 4 weeks of functional training, their older adult participants made significant improvements in upper body strength, lower body strength, and agility/dynamic balance. However, direct comparisons between these studies and the current study should be made with caution due to the differences in the populations studied (older adults *vs.* young adults), and that functional task tests were not administered in the current study, making it unclear if daily performance was improved through the training programs. Again, it is interesting to note that the functional training group showed a similar or higher percent change in 1-RM bench press and squat and push-up in the current study, which are considered to be more traditional means of measuring strength and endurance. Logically, the participants in the traditional study group should have demonstrated greater outcomes due to the specificity of training advantage since the movements involved in training were similar to those performed during testing.

Possible limitations include intertester variability and application of RPE as an intensity method. Regarding intertester variability, the testers all followed the same standardized testing protocol, but may have had slight variations in test administration and motivation given. Also, the degree to which the participants understood the RPE scale may have been a potential limitation. While Sweet et al. (2004) found that the session RPE method was a reliable and useful method to provide progressive increases in resistance, it does depend on understanding the RPE scale. Future research incorporating a functional training program resembling common actions in a college-aged population or with athletes would be interesting, as this training style has only been previously studied in older populations.

In conclusion, this study suggests that functional resistance training could serve as an alternative and potentially more creative method for improving performance in young adults compared to more traditional exercises and could possibly be applied to people of all ages and physical abilities. The overall data indicated that functional training can enhance muscular strength, endurance and balance, which are variables usually associated with programs that involve more traditional resistance training exercises. In addition, it may be possible to maintain or enhance flexibility through functional resistance training due to the nature of the exercises (multi-joint with focus on full range of motion). This could prove useful for aging adults, which is a population that is most associated with poor or declining flexibility. In addition, many of the functional exercises used in this study could be performed in a variety of settings (fitness center, home, traveling), which may enhance adherence due to this inherent flexibility. Lastly and possibly most interesting, this study demonstrated measurable improvements in several of the outcome variables from either functional or traditional resistance training in just 7 weeks of moderate-intensity exercise. However, these results may not be seen as early in a training program with more resistance-trained individuals or athletic populations.

Acknowledgments

The authors would like to thank the study participants for their dedication and effort throughout the course of this study.

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