ASSESSMENT OF THE EASYTONE® EXERCISE PROGRAM ON MUSCULAR STRENGTH AND FUNCTIONAL CAPACITY IN ELDERLY PARTICIPANTS

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INTRODUCTION

The fastest growing segment of the American population is comprised of those 85 years old and older and it has been estimated that by the year 2030 over 20% will be 85 or older. Currently, almost 13% of our population is 65 years of age and older and with the aging of the baby-boomers this figure is expected to rise dramatically over the next three decades. At the beginning of the 1900's fewer than 1 in 25 people in the U.S. were 65 or over (4.1%). By 2004 this number had tripled (12.4%) and between 2000 and 2030, the number of elderly will nearly double to over 20% (Source of data: U.S. Census Bureau, "65+ in the United States: 2005," December 2005).

From 1900 to 1997, the number of persons aged 65 and older increased from 3.1 million to 34.1 million, during which time the total population has only tripled. By 2050, it is estimated that the elderly population will more than double to approximately 79 million. In 1996 the median age of Americans was 35 years, in 1980 it was 30, and in 1900 it was 23. By 2030 the median age is expected to increase to 39 years of age. American demographics will reflect a transformation from a "young" society to a "middle-aged" one. Average life expectancy of Americans is also expected to increase. Currently, life expectancy in the U.S. is about 76 years: 79 years for women and 72 years for men. Furthermore, those who reach the age of 65 have a life expectancy of 82.4 years, an additional 17.4 years (U.S. Census Bureau, U.S. Department of Commerce, Washington, D.C. 20233, March 9, 2006).

Between 2010 and 2030 the “Baby Boom” generation will reach age 65 and this age explosion poses a variety of challenges. One of the critical challenges with the shift in demographics is in maintaining the quality of life. Experts suggest that physical activity retards many age-related changes, reduces the onset of many diseases and increases longevity (1). In contrast, physical inactivity is directly responsible for approximately 30% of all mortality from heart disease, colon cancer and diabetes (2,3). Not only can increased physical activity reduce both morbidity and mortality from these ailments, but exercise also improves muscular and cardiovascular function, reduces the incidence of obesity, and improves overall quality of life (4-9). An active lifestyle also reduces dependency, the risk of disability, and the time spent in health care (10,11).

A prominent age-associated malady is the 40% to 50% loss of muscle strength due to fiber atrophy and loss of motor units. Specific to age-associated muscle detriment is the deterioration of motor unit remodeling leading to denervating muscle atrophy, an irreversible degeneration of the muscle cells. Muscle cell (fiber) degeneration is linked to reduced production of human growth hormone (HGH), insulin-like growth factor-1 (IGF-1), muscle-specific isoforms of IGF, and motor endplate structures (12-16) resulting in sarcopenia, a progressive reduction in muscle cross section and mass (17-19).

Moderate resistance training is a safe and effective means of enhancing protein synthesis and retards the normal, age-related loss of muscle mass and strength (5,20-24). While males achieve greater absolute increases in muscle size and strength than females following resistance training, females realize similar relative gains (25). Research has concluded that 12 weeks of resistance training for those over 65 can significantly improve voluntary muscle strength (26). Indeed, muscle tissue responds to resistance training with improved strength into the ninth decade and improved strength, bone density, and dynamic balance with regular exercise can minimize or reverse age-related physical frailty (27).

While resistance training has been found to be an excellent means by which the elderly can maintain and increase muscle strength, bone mass and functional capacity, standard weight lifting can be both intimidating and hazardous for many. Alternatively, manufacturers have developed an array of exercise equipment utilizing fixed weights, hydraulic components, and elastic resistance, all of which may reduce apprehension and fear of resistance training. A recent development in resistance training equipment by Shapemaster® involves powered exercise equipment. These machines are fitted with motors and gearboxes, and controlled by microchip technology. The machines automatically move selected levers and handles at pre-determined speeds through a pre-determined range of motion (Easytone™). Each machine provides multi-function movements by incorporating both agonist and antagonist muscles. For instance, the seated bench press/row machine is designed to strengthen both the pectoralis major and the latissimus dorsi and associated muscles (i.e., biceps and triceps). Additionally, the machine has foot pedals which are designed to strengthen the hip extensors simultaneously to the upper body work.

The assisted exercise machines provide a safe alternative for individuals who are untrained, have an injury or disability that prevents them from using conventional gym equipment, or is simply too weak to use traditional weight equipment. The uniqueness and stark contrast of these machines when compared to traditional isotonic and isokinetic equipment is that the participants do not attempt to resist the machine's movement, but rather force is applied with the movement of the machine. Consequently, individuals attempt to accelerate the movement of the machine by either pushing or pulling on the handles in the direction that the machine is moving. Consequently, the individual may push or pull at his/her comfort level while contracting the muscles in only the concentric phase. An added attraction to limiting muscle use to concentric contractions is a reduction in delayed onset muscular soreness. Research suggests that concentric muscle actions produce less post-

exercise discomfort than eccentric muscle action, a condition which is particularly magnified in older adults and those lacking muscular strength (28-30). The purpose of this study was to assess the effectiveness of power assisted, resistance exercises on muscle strength and functional capacity of elderly participants following 12 weeks of supervised training.

METHODS

Subjects: Subjects were 53 male (n=15) and female (n=38) volunteers with a mean ± age of 79.4 ±9.8 years living in independent living facilities in a Midwestern city. Subjects were contacted by the researchers and were briefed on the requirements and objectives of the study. Those that volunteered were asked to complete an informed consent document approved by the University Institutional Review Board (IRB). All perspective participants were given an initial screening questionnaire (Par-Q & You) and anyone with existing pathology or risk was omitted from the study. Furthermore, those individuals with any history, signs, or symptoms or diagnosed cardiovascular disease were omitted from the study. All participants were required to complete an Exercise Readiness Questionnaire and to have a physician's approval to engage in exercise.

Procedure: Following the oral briefing, completion of the informed consent document, a health risk questionnaire, and a demographic questionnaire, all participants were given oral instructions and demonstrations on the use of the equipment. They were allowed two sessions to familiarize themselves with each machine prior to baseline data collection. For training, participants were transferred by staff members from their living centers to the training facility 2/wk over a 12 week period with sessions lasting approximately 30 minutes.

Training involved six separate machines specifically designed for selective joint function. The machines consisted of a) left and right torso rotation, b) lateral trunk flexion

with leg press, c) seated shoulder press/ pull downs with leg press, d) seated chest pec decks/reverse flys hip abduction/adduction, e) abdominal crunch and leg press, and f) seated chest press/lat row with leg press. Participants were supervised and proper safety standards and technique were constantly monitored. Data was omitted from analysis for anyone missing over 25% of the exercise sessions. Of the 53 volunteers, 14 were assigned to the control group and were only pre- and post-tested. These participants were asked to maintain their usual activity and lifestyle for the duration of the study. Pre- and post- measures consisted of the following:

- 30-Second Chair Stand Test
- Timed 8-ft Up and Go Test
- Seated 30 sec. Arm Curl
- Bench Press
- Leg Extension
- Triceps Extension
- Modified Berg Balance Scale

30-Second Chair Stand Test: On a signal, the seated participant was asked to rise to a full standing position and then return to a fully seated position and repeat the motion as many times as possible for 30 seconds. Participant's held their arms across their chest during testing. Scoring consisted of the completed number of repetitions in 30 seconds.

Timed 8-ft Up and Go Test: The participant was seated in a chair, hands on thighs and feet flat on the ground. On a signal, he/she would stand up, walk as quickly as possible around a cone placed 8 ft ahead of the chair, and return to a fully seated position on the chair. Scoring consisted of time to completion.

Seated 30-Second Arm Curl: Using their dominant arm male participants used an 8 lb. dumbbell and female participants used a 5 lb. dumbbell and were and asked to lift the weight as many times as possible by flexing the elbow through a full range of motion for 30 seconds. Scoring consisted of the number of repetitions completed in 30 seconds.

Bench Press: During pre-testing Participants were seated in a commercially made exercise machine and were asked to complete full repetitions at a cadence of one repetition per minute with weights of 80 lbs. and 35 lbs. for men and women respectively. Failure to complete a repetition within the cadence signaled the end of the test. Scoring consisted of the number of completed repetitions.

Leg Extension: Participants were seated in a commercially made exercise machine. A submaximal pre-selected weight based on 50% BWT was utilized for both males and females. Scoring consisted of the number of completed repetitions.

Triceps Extension: Participants stood in front of an overhead pulley attached to a commercially made exercise machine. A submaximal pre-selected resistance of 33% BTW weight was used for both males and females. Scoring consisted of the number of completed repetitions.

Modified Berg Balance Scale: Seven items from the 14 item Scale were incorporated into the testing to assess stability and balance. Each item was rated on a 5-point Likert-like scale and scores from the seven tests were added to provide one single score for each individual. The following items were included: 1) Standing unsupported for two minutes, 2) Standing unsupported with eyes closed for 10 seconds, 3) Standing unsupported with feet together for one minute, 4) Reaching forward with outstretched arm while standing, 5) Pick up object from the floor from a standing position, 6) Turn 360 degrees one direction then the other direction, 7) and Standing on one leg.

Data Analysis:

Pre- and post-data were collected and analyses of variance (ANOVA) with repeated measures were used to compare pre- and post-means of each dependent variable (2 time x 2

group). Newman-Keuls post hoc analyses were used to determine the site of significant mean differences. An alpha level of <.05 was used to determine significance. In cases where pre-test means were significantly different between the experimental group and the control group, gain scores were calculated and compared using one-way ANOVAs.

Results:

Means, ± standard deviations, and confidence intervals were calculated and analyses of variance (ANOVA) with repeated measures were conducted on each selected measured variable (Table 1). Analysis yielded significant improvements by the experimental group over the control group in the 30-Second Chair Stand ($F=14.07$, $p=.0005$) and the Timed 8-ft Up and Go ($F=1.94$, $p=0.0133$) test. Significant improvements by the experimental group were also found for the seated 30 Second Arm Curl ($F=17.2$, $p=0.0001$), the Bench Press ($F=20.14$, $p<0.0000$), the Leg Extension ($F=36.73$, $p<0.0000$), the Triceps Extension ($F=32.60$, $p<0.0000$), and in Balance ($F=40.64$, $p<0.0000$) when compared to the control group. However, significant pre-test differences were found for the 30-Second Arm Curl, the Bench Press, Leg Extension, Triceps Extension, and Balance variables. To control for pre-test differences gain scores for each group were analyzed by one-way ANOVAs. Analysis yielded significant gain score improvement for the experimental group in all remaining variables: 30-Second Arm Curl ($F=9.63$, $p=0.0041$), Bench Press ($F=18.33$, $p=0.0001$), Leg Extension ($F=37.61$, $p<0.0000$), Triceps Extension ($F=32.60$, $p<0.0000$) and Balance ($F=34.06$, $p<0.0000$). Figures 1-7 illustrate the contrast between pre- and post-test experimental and control group means.

CONCLUSION

Sarcopenia is age-related degenerative loss of skeletal muscle mass and strength and results in smaller and weaker muscles. While the aging process contributes to the loss of

muscle, lack of exercise may contribute equally. It has been estimated that sedentary elderly have about 60 to 70 percent of the muscle mass found in young adults (31). However, loss of muscular strength can be reversed and significantly improved with proper resistance and weight bearing exercise (32). Additionally, increased muscle strength may help prevent falls and fractures (33). The improvements posted by the treatment group in the area of strength after only 10 weeks were: Chair stand – 29%, Arm curl – 26%, Bench press – 50%, Leg extension – 35%, and Triceps extension – 24%. Additionally, mobility as tested by the Timed 8-ft Up and Go, and Balance increased 22% and 33% respectively (Table 1). While those exercises that were similar to the pre- and post-assessment registered the greatest improvement (bench press and leg extension), the ancillary muscles (biceps and triceps) also experienced significant improvement. Furthermore, it merits mentioning that the exercises performed in the current study were power assisted resistance exercises and no balancing exercises were incorporated in the training. However, correlations of pre-test balance and the 30 sec Chair Stand ($r=0.56$) and pre-test balance and the Timed 8-ft Up and Go were both significant ($r=0.56$ and $r=0.72$ respectively) indicating as strong association between the ability to rise from a chair and to perambulate and selected balance activities. For example poor balance was associated with poor performance on the 30 sec Chair Stand and the Timed 8-ft Up and Go tests. Additionally, the improvement of these variables paralleled an increase in both lower and upper body muscle strength providing evidence of a transfer. Of particular interest concerning the results of this study is the enhancement of balance as tested by the modified Bergs Balance Scale. Falls among the elderly is a tremendous health problem. More than 90% of hip fractures among adults ages 65 and older are caused by falls (34). These injuries can cause severe health problems and lead to reduced quality of life and premature death (35-36).

In 2000, the total direct cost of all fall injuries for people 65 and older exceeded $19 billion (34). The financial toll for older adult falls is expected to increase as the population ages, and may reach $54.9 billion by 2020. A prominent focus for fall prevention has been to restructure the environment. For example, eliminating throw rugs, proper lighting, hand rails, etc. More recently, emphasis has been placed on strength and balance training as a preventative for falls. The use of the power assisted machines as in the current study, in addition to selected balance training provides a healthy means by which to reduce falls and the medical expenditures that frequently follow.

Participants' Debriefing Comments

Patient satisfaction surveys are often done in medical research to ascertain both effectiveness and approval. For the current study, the researchers debriefed the participants after the 12-week exercise program to gain an understanding of the prevailing attitudes toward the exercise program, their perceived physical changes, and their attitudes toward exercising with the selected equipment. The following are some of their comments:

Participants' Debriefing Comments After 12 Weeks of Exercise.

<u>Comments About the Exercise Program:</u>

Ms. MA: Loved the program!
Ms. MT: Delightful – Great Program
Ms. MH: Like the program and can tell that it's helped her.
Ms. JS: Love the machines! It would be nicer to use them more than twice a week.
Mr. EF: Liked the program but would have liked to have been able to come more than twice a week
Mr. BS: Really enjoyed the program and all of her muscles seem to be getting stronger.
Mr. RB: Liked the program. He can tell that it has already helped some but would have liked to have been able to go longer than 12 weeks.
Ms. NS: Enjoyed program.
Ms. MD: I like it very much
Ms. HC: Impressed and happy with the program
Ms. AMB: "Loved it honey" was her first comment.
Ms. TS: Extremely grateful to be able to do the program.
Ms. RM: Enjoyed every minute of the program!
Mr. OA: Fantastic!

Outcomes:

Ms. MA: She said that it feels like you have exercised without over tiring or hurting. Doesn't hurt her neck and that was a big concern of hers.
Ms. MT: Big time improvement! There is not anyone that has been in the program that hasn't been energized!
Ms. JS: Loves the Tummy Crunch machine as it helps her back
Mr. WP: He feels better now that he is exercising and his legs are doing better.
Ms. NS: Naomi said that she isn't breathing as hard when she walks now. She has also lost some weight. Machines are excellent!
Ms. AF: Her shoulder is doing wonderful. She was told that she was going to need physical therapy on her shoulder but her Dr. says that she doesn't need it now. Range of motion has really improved.
Ms. MD: Balance is getting better and she feels stronger.
Mr. GH: He said that he is walking better and the strength in his legs and shoulders has improved. Pain is almost gone the day after he works out. The workouts have definitely helped him!
Ms. HC: Really thinks that the exercise program has helped her everywhere.
Ms. TS: Loves to use the machines and can tell that it has helped her walking. She can tell that she has gained some strength in her legs.
Mr. OA: He feels better than he has in 2 or 3 years. Loves all of the machines .
Mr. IR: He said that this has been very good for him and he feels much better. He is stronger and it has helped him walk.
Mr. MH: Arms are so much stronger and her legs are too.
Ms. DC: Squatting is easier and her legs have gotten stronger.

Consistency:

Ms. MT: She said that she would use the machines every single day if she could because they energize her.
Ms. MH: Would like to be able to use the machines everyday and for more than 5 minutes each time if possible.
Mr. EF: said that he liked the program but would have liked to have been able to come more than twice a week. If he had the machines available to him he would definitely work out more than twice a week.
Mr. RB: He can tell that it has already helped some but would have liked to have been able to go longer than 12 weeks.
Ms. NS: Enjoying exercise more now that she used to.
Ms. MD: Would like very much to continue working on the machines.
Ms. KS: She has always enjoyed exercising and really enjoys the machines.
Ms. AMB: She said that she would love to have the machines available all the time.
Mr. SS: Liked the program and said that she always looks forward to coming.
Ms. RM: She would use the machines more if they were available.
Ms. PR: She would use the machines everyday if she could.
Ms. BP: Would like to see the program continue. She would definitely use the machines if they were available and she thinks that everyone else would too. The machines are pleasant to use. Her only negative comment was that the program was going to end.

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Variable	Pre-Mean	SD	CI -95% , +95%	Post-Mean	Gain	SD	CI -95%, +95%	F	P
Experimental Chair Stand	8.47	0.64	1.19 – 9.76	10.89	+29%	0.55	9.87 – 11.99	7.28	0.009
Control Chair Stand	8.36	0.81	6.71 – 10.00	8.57	+3%	0.76	7.03 – 10.11		
Experimental 8-ft Up&Go	13.52	1.07	11.35 – 15.69	10.57	+22%	0.75	9.05 – 12.09	6.68	0.013
Control 8-ft Up&Go	12.18	2.28	7.57 – 16.78	12.28	-1%	1.60	9.05 – 15.51		
Experimental Arm Curl	9.60	0.96	7.66 – 11.54	12.09	+26%	0.80	10.47 – 13.70	17.29	0.000
Control Arm Curl	16.42	1.52	13.35 – 19.49	13.71	-17%	1.27	11.15 – 16.27		
Experimental Bench Press	7.36	0.64	6.07 – 8.66	11.05	50%	0.74	9.55 – 12.55	20.14	0.000
Control Bench Press	12.14	1.06	10.03 – 14.27	12.28	-1%	1.23	7.81 – 12.75		
Experimental Leg Ext	9.89	0.68	8.52 – 11.27	13.31	+35%	0.71	11.87 – 14.75	36.73	0.000
Control Leg Ext	15.14	1.12	12.87 – 17.40	13.14	-13%	1.18	10.76 – 15.51		
Experimental Triceps Ext	12.79	0.53	11.72 – 13.86	15.87	+24%	0.69	14.48 – 17.26	32.60	0.000
Control Triceps Ext	13.85	0.89	12.07 – 15.64	12.29	-11%	1.56	9.96 – 14.60		
Experimental Balance	15.86	0.77	14.30 – 17.42	21.05	+33%	0.54	19.96 – 22.15	40.64	0.000
Control Balance	21.28	1.28	18.71 – 23.85	21.00	-1%	0.88	19.19 – 22.80		

Figure 1. Pre- and Posttest 30 Second Chair Stand Means by Group.

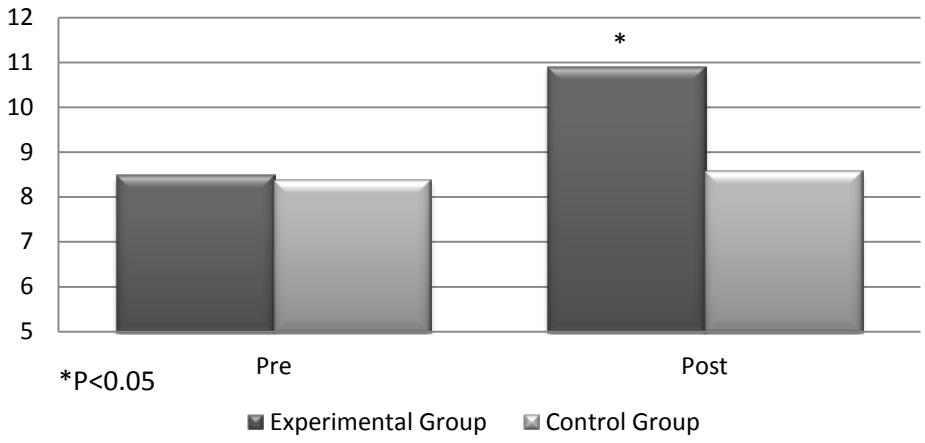
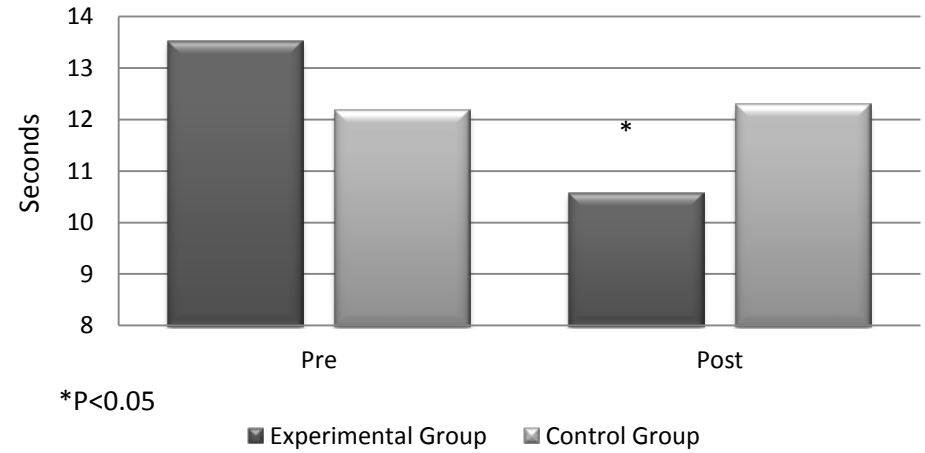


Figure 2. Pre- and Posttest Timed 8 ft. Up and Go Test Means by Group.



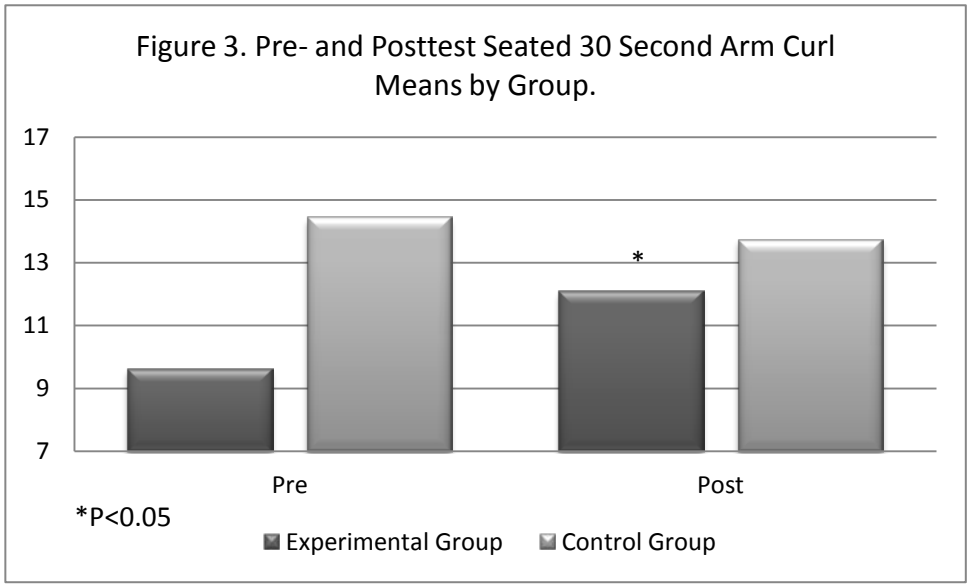


Figure 3. Pre- and Posttest Seated 30 Second Arm Curl Means by Group.
17
15
13
11
9
7
*
Pre
Post
*P<0.05
Experimental Group
Control Group

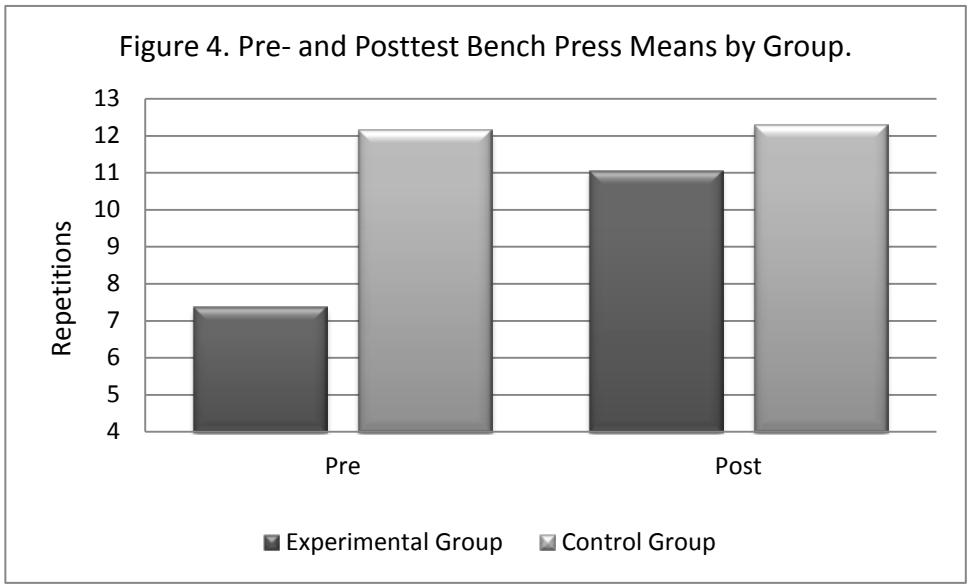


Figure 4. Pre- and Posttest Bench Press Means by Group.
Repetitions
13
12
11
10
9
8
7
6
5
4
Pre
Post
Experimental Group
Control Group

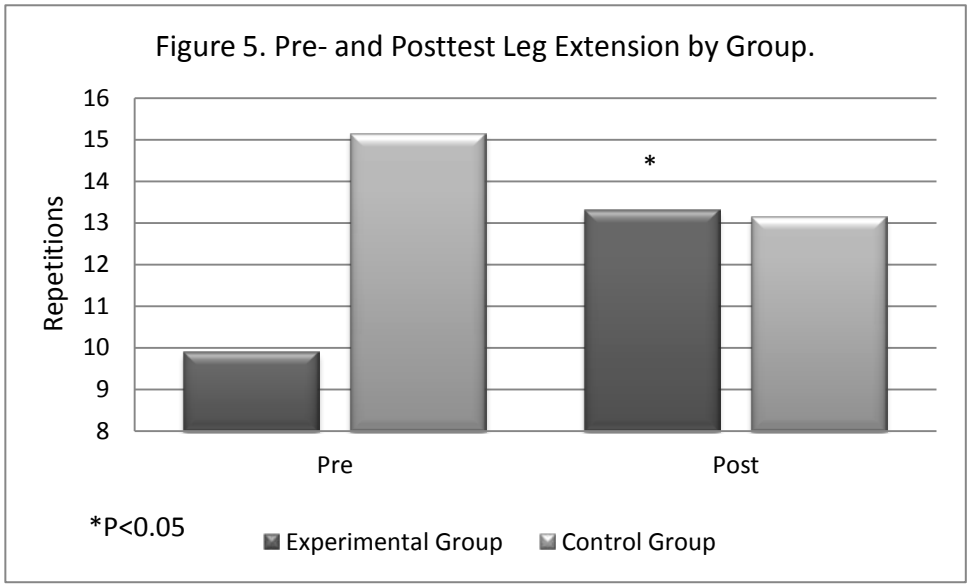


Figure 5. Pre- and Posttest Leg Extension by Group.
16
15
14
13
12
11
10
9
8
Repetitions
*
Pre
Post
*P<0.05
Experimental Group
Control Group

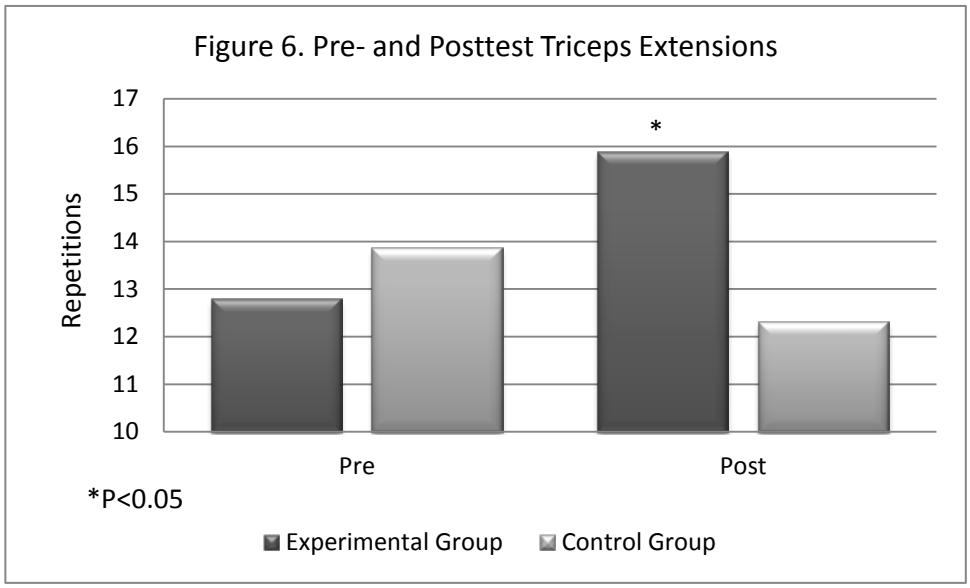


Figure 6. Pre- and Posttest Triceps Extensions
17
16
15
14
13
12
11
10
Repetitions
*
Pre
Post
*P<0.05
Experimental Group
Control Group

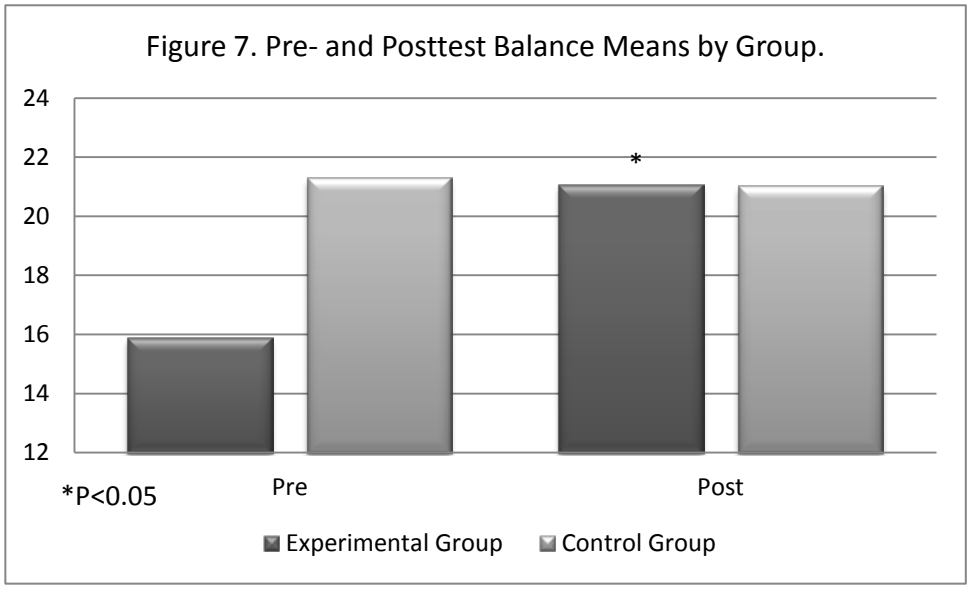


Figure 7. Pre- and Posttest Balance Means by Group.
24
22
20
18
16
14
12
*
*P<0.05
Pre
Post
Experimental Group
Control Group