THE EFFECTS OF A 10-WEEK RESISTANCE TRAINING
PROGRAM ON FUNCTIONAL PERFORMANCE
OF FEMALE CARDIAC PATIENTS

A MANUSCRIPT STYLE THESIS PRESENTED
TO
THE GRADUATE FACULTY
UNIVERSITY OF WISCONSIN-LA CROSSE

IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE
MASTER OF SCIENCE DEGREE

BY
STEFANIE K. HATCHER

DECEMBER 2000

COMPLETED RESEARCH IN HEALTH, PHYSICAL EDUCATION, RECREATION
AND DANCE

University of Wisconsin-La Crosse

G. Tymeson
Institutional Representative

HATCHER, S. K. The effects of a 10-week resistance training program on functional performance of female cardiac patients. MS in Adult Fitness/Cardiac Rehabilitation, December 2000, 39pp. (J. Porcari)

Loss of function with age is exacerbated when combined with cardiovascular disease. The purpose of this study was to determine the effects of a 10-week resistance training (RT) program on activities of daily living (ADL's) in female cardiac patients. A total of 22 women enrolled in a Phase III cardiac rehabilitation aerobic training program participated in the study. Subjects were assigned to either an experimental (n = 12) or control (n = 10) group. Subjects were measured on 7 functional ADL tests before and after the RT program. The tests included chair-sit-to-stand, up-&-go, functional reach, floor rise, single-leg-stand, grocery carry, and stair climb. The training protocol consisted of 9 upper and lower extremity exercises performed 3 times a week. The experimental group increased overall upper body (+39%) and lower body (+101%) strength with RT. Significant changes ($p < 0.05$) were found between the experimental and control groups in the up-&-go (11%) and sit-to-stand (26%) tests. Improvements in the functional reach (15%), floor rise (10%), single-leg-stand (9%), grocery carry (11%), and stair climb (8%) tests were also found, but were not significant. In conclusion, it appears that RT in addition to aerobic training can improve the performance of ADL's in a Phase III female cardiac population.

COLLEGE OF HEALTH, PHYSICAL EDUCATION, AND RECREATION

UNIVERSITY OF WISCONSIN-LA CROSSE

THESIS FINAL ORAL DEFENSE FORM

Candidate: Stefanie Hatcher

We recommend acceptance of this thesis in partial fulfillment of this candidate's requirements for the degree:

Master of Science- Adult Fitness/Cardiac Rehabilitation

The candidate has successfully completed the thesis final oral defense.

Thesis Committee Chairperson Signature 4/13/00
Date

Thesis Committee Member Signature 4/13/00
Date

Thesis Committee Member Signature 4/13/00
Date

This thesis is approved by the College of Health, Physical Education, and Recreation.

Associate Dean, College of Health,
Physical Education, and Recreation 5-3-00
Date

Dean of Graduate Studies 5-3-00
Date

ACKNOWLEDGEMENTS

I would like to thank Dr. John Porcari, my thesis chairperson and ringleader for the last year. Also, a sincere thank you to Drs. Travis Triplett-McBride, John Betton, and Carl Foster who were all involved in the production of my thesis. Thesis preparation would not have been possible without their guidance.

I would also like to thank my family and friends for their love and support during this experience know as "Graduate School". Without their encouragement and care packages, I would not have made it. Special thanks goes to Chris Hansen for his enduring love and support, without him this would not have been possible.

I must also thank my thesis partner, Carla Theusch. Without her organization, patience, and constant understanding I would have never finished. I could not have done it without her.

And finally, to my year 2000 classmates, the experiences we had will always bring laughter and a smile to my face. Thank you for sharing the last year with me and I wish you all the best.

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS.....	iii
LIST OF TABLES.....	v
LIST OF APPENDICES.....	vi
INTRODUCTION.....	1
METHODS.....	3
Introduction.....	3
Subject Selection.....	3
Testing Procedures.....	4
Exercise Training.....	7
RESULTS.....	8
Strength Improvements.....	8
Physical Performance Improvements.....	11
DISCUSSION.....	12
REFERENCES.....	16
APPENDICES.....	20

LIST OF TABLES

TABLE	PAGE
1. Subject Characteristics.....	9
2. Mean and Standard Deviations of Strength Gains.....	10
3. Mean and Standard Deviations of Activities of Daily Living Tests.....	11

LIST OF APPENDICES

APPENDIX	PAGE
A. Informed Consent.....	20
B. Physician Clearance.....	24
C. Subject Information Sheet.....	27
D. Review of Related Literature.....	29

INTRODUCTION

Age-related loss in function is related to increased mortality and morbidity in older adults. The two most common causes of the loss in function are decreased muscular strength and chronic disease. Many older adults blame their decreased physical activity on these problems. Previous research has shown that physical activity can reverse many age-associated declines in functioning.

Aging has been shown to have adverse effects on muscle mass, strength, endurance, and with changes in balance and body composition.^{1,2} In an overview of previous literature, Chandler and Hadley³ found that lower extremity weakness was associated with a decrease in functional performance measures. Numerous studies have also been completed on balance and gait, and their relationships with lower body weakness and functional performance.⁴⁻⁸ The most common physical activity used to improve many of these functional measures was resistance training.

Fiatarone et al.⁹ tested strength gains from resistance training in subjects that were over the age of 90 and found increases in strength and functional performance. Gait speed was increased and subjects were able to walk without devices to aid them. Studies specifically on women have shown similar effects after participating in a resistance training program.¹⁰⁻¹⁴ Chandler et al.¹⁵ studied older males and females through 10 weeks of training and found a significant correlation between strength gains, gait speeds, and

mobility tasks. Women in the studies have had even greater increases in strength than men in the same programs.

One population that is highly susceptible to decreased levels of physical activity and function are adults with cardiovascular disease (CVD). In addition to reversing losses of function due to inactivity, adults with CVD also need to overcome physical limitations exacerbated by their disease. A large area of concern for CVD patients is the loss of the ability to perform activities of daily living. Previous studies have found that functional capacity for daily activities of CVD patients was lower as a result of the disease.¹⁶⁻¹⁸ The ability to perform activities of daily living (ADL's) can be hampered by chronic angina, hypertension, fatigue, shortness of breath, and decreased self-efficacy.

Numerous studies have been done on exercise training and function in the older adult population, but only recently have studies been done on adults with cardiovascular disease. Previously, it was felt that the increased demand on the heart from resistance training was unsafe for patients with heart disease. It is now widely accepted that when executed properly, resistance training is safe for low, moderate, and even high risk cardiac rehabilitation patients.¹⁹⁻²²

Not only has resistance training been shown to be safe, it is now known to be effective at increasing functional performance in people with CVD. Verrill²² found an increase in strength produced a decreased workload for the cardiovascular system during exercise. Parker et al.²³ found that after a 16-week resistance training program, older women had decreased stress on their cardiovascular system while performing a weight-loaded walking test.

There is however, a lack of research specifically on improving the function of daily activities in adults with CVD. Additionally, there is a lack of research on female cardiac patients. Of the studies that have been done, few included women and none have tested women alone. This training program was implemented to study the effects of resistance training on performance of daily activities of female cardiac rehabilitation participants.

METHODS

Introduction

This project investigated the effects of a 10-week resistance training (RT) program on functional performance in females. The study was related to a concurrent study investigating strength changes and self-efficacy in the same group of females. The effects of the RT on muscular strength and endurance will be correlated to changes in functional performance. The Institutional Review Boards of the University of Wisconsin-La Crosse (UW-L) and Franciscan Skemp Healthcare approved both studies.

Subject Selection

The study involved 22 female volunteers that were currently participating in a Phase III cardiac rehabilitation program at Franciscan Skemp Healthcare in La Crosse, WI. The cardiac rehabilitation program involved only aerobic exercise at the time of the study. Prior to participation, subjects were required to read and sign an informed consent (Appendix A). Physician clearance (Appendix B) was also received before any testing or training was initiated. After all necessary paperwork was submitted, subjects were then randomly assigned to either the experimental ($n = 12$) or control ($n = 10$) group. All

participants, whether control or experimental, participated in testing procedures before and after the 10-week period.

All of the participants were functionally able to participate, clinically stable, and met the guidelines set by the AACVPR, ACSM, and AHA, for inclusion in a RT program.²⁴⁻²⁶ The following exclusion criteria were used in subject selection:

1. abnormal hemodynamic responses or ischemic changes documented during their current cardiac rehabilitation exercise sessions
2. ejection fraction of ≤ 30 , representing poor left ventricular function
3. a functional capacity of < 4 -5 METS
4. uncontrolled angina, hypertension, dysrhythmias, or heart failure
5. severe CAD
6. severe aortic stenosis
7. orthopedic or cardiovascular limiting symptoms
8. characteristics that may increase the risk of a cardiac event with exercise

Testing Procedures

Muscular strength and functional testing were completed one week prior to initiation of training and one week after training was completed. Subjects were tested on functional abilities before the muscular strength testing to avoid muscular fatigue. Functional tests were given in the same order for all participants, and rest periods were allowed between tests. The tests assessed agility, balance, and muscular strength and endurance. Timed tests were recorded to the nearest 0.1 second.

Chair sit-to-stand. A metal, straight-back chair with a seat height of 18 inches was used. The subjects wore low-heeled shoes that were comfortable for physical activity. Encouragement was given to complete the task as fast as possible.

Subjects were allowed one practice stand before timing was started. The subjects started in a seated position with arms to their side. No arm push-off was allowed. The subjects were told to rise from the chair into a fully standing position and then to sit back down again until 10 repetitions were completed. Timing was initiated when the subject began to rise from the chair and was stopped after coming to a fully seated position after the 10th stand. The time to complete 10 full sit-to-stands was recorded from a digital stopwatch.

Floor rise. Subjects began in a seated position, with legs fully extended, on the floor. A tester was standing next to the subject for safety. They were asked to come to a complete stand without the help of a device to pull themselves up. Timing was initiated when the subject began to move from the floor. Two trials were allowed and the faster of the two times was recorded. Each subject was encouraged to stand as quickly as possible.

Up-and-go. A metal, straight-back chair with a seat height of 18 inches was placed against a wall. A cone was placed eight feet in front of the chair on a level surface. The eight feet were measured from the front edge of the chair to the back of the cone. The subjects started in a seated position with their hands on their legs. A "Go" signal was given to the subjects and the time was started. The subject then rose from the chair, walked quickly around either side of the cone, and returned to a seated position.

No running was allowed. A demonstration was given, and the better of two timed trials was recorded.

Grocery carry. Each subject was asked to lift a canvas bag containing weights from the floor onto a table (height = 29 inches). The weights used were one pound each, and the subjects were tested on the maximal amount they could lift with one arm. The initial weight was determined by the subject and was progressively increased by one to five pounds each time. The maximal amount lifted by one arm was recorded.

Single-leg stand. Subjects started with both feet on the ground and arms to their sides. Timing was started when the subject lifted one foot off the floor. The time was stopped when the subject placed the foot back on the ground, bounced around, or used their arms for balance. Two trials were executed on the dominant leg and the longest time for each was recorded. The test was performed with their shoes on and their eyes open.

Functional reach. The test consisted of a yardstick taped to a wall at the height of the subject's right acromion. A tracing of two feet was taped on the floor for the placement of the subjects to stand on. The subjects were told to hold their right arm straight out in front of them (at approximately a 90 degree angle), and reach forward as far as possible without stepping or losing their balance. No contact with the wall was allowed. A tester stood next to the subject for safety.

The subjects performed three trials and the distance from the starting position to the reached position was measured. The reached position was the furthest point reached by the middle finger. The longest of the three trials was recorded.

Stair climb. The subjects were asked to climb a staircase at a comfortable pace, without stopping or using the handrail, for as far as possible. The maximal distance was eight flights of 10 stairs each. Heart rates, steps taken, and total time were recorded. Speed was then calculated in steps/second.

Strength testing. Subjects were tested on each machine using the one-repetition maximum (1-RM) method. An orientation and practice session was used to familiarize the subjects with the equipment and to teach proper lifting and breathing techniques. A five to ten minute warm-up was required before 1-RM testing was conducted. The 1-RM was considered to be the maximal amount of weight that could be lifted, through a complete range of motion, only once. The research staff chose the initial sub-maximal weight. Further increments were determined by the subject's difficulty with the previous weight. Increments ranged from two to ten pounds, but as the subject reached maximum, the increments were decreased to one to three pounds. Equipment positioning for each subject, along with identical testing procedures, were used for the post-tests one week after the training was completed.

Exercise Training

Supervised training sessions were held three days a week, for approximately 45 minutes. Heart rate, blood pressure, and ratings of perceived exertion were monitored, along with occasional ECG monitoring. The 10-week RT program consisted of nine exercises for the upper and lower body. The exercises included leg press, bench press, shoulder press, biceps curl, triceps extension, one arm pull, leg extension, hamstrings curl, one arm pull, and calf raise. Exercises were alternated between upper and lower

body when possible, with two-minute rest intervals between machines and one minute between sets.

Initial loads for weeks one through four were two sets of 12-15 repetitions at 50% of the tested 1-RM. Weeks five through seven and eight through ten were at a self-selected weight load that enabled two sets of 10-12 repetitions and two sets of 8-10 repetitions, respectively.

RESULTS

A total of 22 women participated in the study, including 12 in the training group and 10 in the control group. Subject characteristics, including primary clinical diagnosis, are presented in Table 1. There were no significant differences between the control and experimental groups in age, height, weight, or time in rehabilitation. Compliance by the experimental group for the 10-week RT program was 82%. Subjects attended an average of 23 out of 28 possible sessions. One subject began the study in the training group, but switched to the control group due to orthopedic limitations. Another subject in the training group was unable to perform upper body exercises for the last five weeks and was therefore only tested on lower body exercises.

Strength Improvements

The experimental group had significant improvements ($p < 0.05$) in 1-RM strength from pre- to post-test in all exercises except the biceps curl (Table 2). The resistance training improved upper body strength by an average of 39% and lower body strength by 101%. The only significant improvement ($p < 0.05$) in the control group was found in leg extension strength (30%).

Table 1. Subject Characteristics

Subjects	Age (yr.)	Height (in.)	Weight (lb.)	Clinical Diagnosis	Time in Rehab (months)
Trained					
1	74	65	177	MI	1
2	71	67	168	atrial arrhythmia	75
3	75	69	170	CABG x2	27
4	73	63	140	CABG x3	6
5	72	60	125	angina	2
6	77	63	165	MI, pacemaker	25
7	69	63	199	CABG x4	6
8	68	64	235	PTCA	11
9	71	63	206	cardiomyopathy	35
10	76	70	155	angina	6
11	72	62	162	CHF, stroke	53
12	76	68	219	pacemaker	23
Mean $\pm$ SD 72.8 $\pm$ 2.86 64.8 $\pm$ 3.08 176.8 $\pm$ 32.35 22.5 $\pm$ 22.77					
Control					
1	81	66	146	MI	30
2	67	62	123	Angiogram	36
3	71	69	193	CABG x2	14
4	72	64	175	CABG x4	33
5	74	63	209	CABG x3	3
6	81	61	159	CABG x5	35
7	69	65	100	PTCA	21
8	73	65	210	CABG x3	30
9	84	62	120	CABG x4	66
10	82	63	122	CABG x1, CHF	21
Mean $\pm$ SD 75.4 $\pm$ 6.06 64.0 $\pm$ 2.36 163.7 $\pm$ 35.1 28.9 $\pm$ 16.67					

MI = myocardial infarction, CABG = coronary artery bypass graft,
PTCA = percutaneous transluminal coronary angioplasty,
CHF = congestive heart failure, LVH = left ventricular hypertrophy

Table 2. Mean and Standard Deviations of Strength Gains

Exercise/Group	Pre-test	Post-test	Percent Change
Chest Press			
<i>Experimental</i>	55.5 ± 12.14	75.0 ± 10.72*	35
<i>Control</i>	52.0 ± 16.87	51.0 ± 14.49	-1
Leg Press			
<i>Experimental</i>	96.7 ± 45.74	215.0 ± 50.68*	122
<i>Control</i>	111.5 ± 51.10	124.5 ± 50.25	12
Shoulder Press			
<i>Experimental</i>	9.5 ± 2.49	13.1 ± 2.87*	38
<i>Control</i>	7.8 ± 3.98	8.3 ± 3.79	6
Leg Extension			
<i>Experimental</i>	32.7 ± 15.46	55.2 ± 20.77	60
<i>Control</i>	22.0 ± 10.12	28.5 ± 20.79	30
Biceps Curl			
<i>Experimental</i>	13.3 ± 2.50	15.6 ± 2.55	17
<i>Control</i>	9.8 ± 3.62	10.5 ± 3.21	7
Leg Curl			
<i>Experimental</i>	28.8 ± 10.85	45.0 ± 13.4	56
<i>Control</i>	19.0 ± 9.44	19.5 ± 9.19	5
Tricep Press			
<i>Experimental</i>	11.9 ± 2.91	16.2 ± 1.86*	36
<i>Control</i>	9.2 ± 3.19	9.7 ± 3.23	5
Calf Raises			
<i>Experimental</i>	75.8 ± 27.46	200.0 ± 42.72*	164
<i>Control</i>	96.0 ± 42.22	106.0 ± 48.35	10
One Arm Pull			
<i>Experimental</i>	16.0 ± 3.17	26.8 ± 4.05*	68
<i>Control</i>	13.9 ± 6.21	14.7 ± 6.87	6

* A significant difference ($p < 0.05$) from pre-test to post-test values.

Physical Performance Improvements

Results for the functional measures are presented in Table 3. Improvements were seen in all of the functional measures for the trained group, however only the up-and-go and the sit-to-stand tests were found to be significant ($p < 0.05$). The control group stayed the same for all measures except the single-leg-stand (-17%) and the stair climb (-4%) where they declined in performance.

Table 3. Mean and Standard Deviations of Activities of Daily Living Tests

Test/Group	Pre-test	Post-test	Percent Change
Up & Go			
<i>Experimental</i>	7.2 ± 2.11	6.4 ± 1.90*	-11
<i>Control</i>	7.9 ± 1.47	7.83 ± 1.92	0
Sit-to-Stand			
<i>Experimental</i>	30.4 ± 9.64	22.4 ± 5.40*	-26
<i>Control</i>	27.5 ± 3.43	27.6 ± 3.71	0
Functional Reach			
<i>Experimental</i>	24.4 ± 7.50	28.1 ± 7.95	+15
<i>Control</i>	24.5 ± 9.13	24.3 ± 8.92	0
Floor Rise			
<i>Experimental</i>	6.8 ± 5.81	6.1 ± 5.07	-10
<i>Control</i>	6.0 ± 3.27	6.1 ± 3.84	0
Single Leg Stand			
<i>Experimental</i>	11.3 ± 8.01	12.3 ± 11.41	+9
<i>Control</i>	8.9 ± 7.54	7.4 ± 4.33	-17
Grocery Carry			
<i>Experimental</i>	20.0 ± 5.02	22.1 ± 4.65	+11
<i>Control</i>	13.3 ± 5.26	13.9 ± 4.71	0
Stair Climb-steps/sec.			
<i>Experimental</i>	0.93 ± 0.25	1.0 ± 0.30	+8
<i>Control</i>	0.99 ± 0.31	0.95 ± 0.29	-4

* Change was significantly different than the control group ($p < 0.05$)

DISCUSSION

This study showed that a high-intensity resistance training program, added concurrently to a Phase III cardiac rehabilitation aerobic exercise program, improved both strength and functional performance of female participants. Although previous studies implemented RT programs for healthy older adults, few have included adults with documented cardiovascular disease (CVD).

Exercise training studies on male and female patients with CVD have elicited strength gains comparable to our study. Fragnoli-Munn et al.²⁷ saw improvements of 29% in the bench press and 66% in the leg extension of their female cardiac patients after 12-weeks of training. In comparison, our improvements were 35% for the chest press and 60% for the leg extension after 10-weeks of training. Adams et al.¹⁹ had a significantly lower overall training stimulus, and their females only had a 21% increase in overall upper body strength, compared to an overall upper body improvement of 39% in the current study. The subjects in Adams et al.¹⁹ only completed three upper and two lower body exercises and the subjects in Fragnoli-Munn and associates²⁷ completed four upper body and two lower body exercises. The RT in the current study included a total of nine exercises that included five upper body and four lower body, thus providing a larger overall training stimulus. The differences in the overall training stimulus, in previous studies when compared to the current study, may account for the differences in strength changes that were seen.

Functional tests are used to assess the ability to live independently, to assess the level of frailty or disability, and to predict the likelihood of future falls.^{3,8,12,28} The functional performance measures used in this study represent a sample of the tests that have been created for older adults and diseased populations. This is one of the first studies to use such a battery on patients with documented CVD.

Usually, functional performance of patients with CVD is tested on a treadmill or cycle ergometer to assess improvements in aerobic capacity.²⁹⁻³¹ Although aerobic capacity is related to the amount and intensity of activity a person can perform, it is not a good indicator of the ability to perform ADL's.^{24,25} The performance of ADL's requires mobility, static and dynamic balance, endurance, flexibility, and self-confidence.^{3,24,25}

The present study included tests for mobility, static and dynamic balance, strength, and endurance, while a concurrent study evaluated strength and self-efficacy. Static balance was measured using the functional reach and one-leg-stand-time (OLST) tests. The OLST has been used as a tool for distinguishing the risk of future falls and as a clinical tool for balance.^{8,12} Although exercise training in the present study did not significantly affect the OLST of the experimental and control groups, the experimental group improved 9% while the control group declined 17%. This is similar to 6% improvement and a 33% decline of experimental and control groups seen by MacRae and associates.¹²

Changes in functional reach scores after exercise training have also seen mixed results. Chandler et al.¹⁵ found no correlation between strength changes and functional reach scores in their frail community dwelling adults. In the current study, functional

reach did improve 15% in the experimental group, but due to the large amount of variability in scores, the difference was not statistically significant. These results are similar to the small amount of change seen in trained females in a previous study.¹⁴

Previous authors who have tested balance by postural sway have shown few significant improvements from a general training program.^{6,7,11,32} The authors concluded that the exercise program was not training the specific muscles that are used for balance, and therefore would not promote significant changes. The balance changes in the current study seem to be consistent with these findings. It appears that a general RT program may not improve measures of balance, but it may be responsible for reducing the loss of balance typically seen with aging and disuse.

Mobility and dynamic balance were tested using the timed up-and-go (UG) test. The UG has been found to correlate well with more specific balance and gait speed tests.³³ Both experimental and control subjects in our study had better timed UG pre-test scores than two groups of community dwelling elderly volunteers.^{33,34} Our subjects performed a mean score of 7.5 ± 1.84 seconds while the subjects in previous studies performed 9.8 ± 1.8 seconds³³ and other subjects ranged from 10 to 240 seconds.³⁴ Differences in the scores may be attributed to the amount of exercise training the subjects were participating in prior to the study. Our subjects had been engaged in an aerobic exercise training program for an average of two years prior to the RT program. Subjects in the previous study were only engaging in normal daily activities before they entered the exercise training program.

The chair sit-to-stand (STS) was used in the current study as a functional test to measure strength and endurance of the lower body. Fiatarone⁹ used a single-stand version of the test on nonagenarians and found that quadriceps strength was inversely related to the chair stand time. Brill and associates³⁵ found a 50 and 40% improvement in time to stand once and time to stand five times, respectively. These improvements were seen in the subjects after 12 weeks of RT. The current study elicited a 26% improvement in the experimental group, while no change was seen in the control group.

Significant improvements after 10-weeks of RT were seen in strength, lower extremity endurance (Sit-to-stand), and mobility and dynamic balance (Up and Go). The largest improvements were found in the females who were initially functionally limited. This is in agreement with previous literature that found exercise training improved function to a greater degree in frail individuals than in healthy individuals.^{3,6,11,15,36}

This study has shown that RT for diseased populations does result in large improvements in upper and lower body strength, which in turn, will improve function and the performance of ADL's. Current and past research has found exercise training to improve functional performance, but more specific training protocols are needed to significantly improve performance of ADL's in healthy and diseased populations. Improving function will allow more adults to live independently and with an increased quality of life.

REFERENCES

1. Booth FW, Weeden SH, Tseng BS: Effects of aging on human skeletal muscle and motor function. *Med Sci Sports Exerc* 1994; 26:556-560.
2. Kauffmann T: Functional Performance in Older Adults. Philadelphia: Davis, 1994; 42-59.
3. Chandler JM, Hadley EC: Exercise to improve physiologic and functional performance in old age. *Clin Geriatr Med* 1996; 12:761-784.
4. Fiatarone MA, Evans WJ: The etiology and reversibility of muscle dysfunction in the aged. *J Gerontology* 1993; 48:77-83.
5. Hunter GR, Treuth MS, Weinser RL, et al: The effects of strength conditioning on older women's ability to perform daily tasks. *J Am Geriatr Soc* 1995; 43:756-760.
6. Lord SR, Castell S: Physical activity program for older persons: Effect on balance, strength, neuromuscular control, and reaction time. *Arch Phys Med Rehabil* 1994; 75:648-652.
7. Lord SR, Ward JA, Williams P, Strudwick M: The effects of a 12-month exercise trial on balance, strength, and falls in older women: A randomized controlled trial. *J Am Geriatr Soc* 1995; 43:1198-1206.
8. MacRae PG, Lacourse M, Modavon R: Physical performance measures that predict faller status in community-dwelling older adults. *J Ortho Sport Phys Ther* 1992; 16:123-128.
9. Fiatarone MA, Marks EX, Ryan ND, Meredith CN, Lipisitz LA, Evans WJ: High-intensity strength training in nonagenarians: Effects on skeletal muscle. *JAMA* 1990; 263:3029-3034.
10. Ades PA, Ballor DL, Ashikaga T, Utton JL, Nair KS: Weight training improves walking endurance in healthy elderly persons. *Ann Int Med* 1996; 124:568-571.
11. Judge JO, Lindsey C, Underwood M, Winsemius D: Balance improvements in older women: Effects of exercise training. *Phys Ther* 1993; 73:254-265.

12. MacRae PG, Feltner ME, Reinsch S: A 1-year exercise program for older women: Effects on falls, injuries, and physical performance. *J Aging Phys Activ* 1994; 2:127-142.
13. Sipila S, Suominen H: Effects of strength and endurance training on thigh and leg muscle mass and composition in elderly women. *J Appl Physiol* 1995; 78:334-340.
14. Skeleton DA, Young A, Greig C, Malbut KE: Effects of resistance training on strength, power, and selected functional abilities of women aged 75 and older. *J Am Geriatr Soc* 1995; 43:1081-1087.
15. Chandler JM, Duncan PW, Kochersberger G, Studenski S: Is lower extremity strength gain associated with improvement in physical performance and disability in frail, community-dwelling elders? *Arch Phys Med Rehabil* 1998; 79:24-30.
16. Neill WA, Branch LG, DeJong G, et al: Cardiac disability: The impact of coronary heart disease on patient's daily activities. *Arch Int Med* 1985; 145:1642-1647.
17. Nickel JT, Chirikos TN: Functional disability of elderly patients with long-term coronary heart disease: A sex stratified analysis. *J Gerontol* 1990; 45:S60-68.
18. Rozzini R, Ferrucci L, Barbsoni P, Bertozzi B, Trabucchi M: The effect of chronic diseases on physical function. Comparison between activities of daily living scales and the Physical Performance Test. *Age Aging* 1997; 26:281-287.
19. Adams KJ, Barnard KL, Swank AM, Mann E, Kushnick MR, Denny DM: Combined high-intensity strength and aerobic training I diverse Phase II cardiac rehabilitation patients. *J Cardiopulm Rehabil* 1999; 19:209-215.
20. Butler RM, Beirwaltes WH, Rogers FJ: The cardiovascular responses to circuit weight training in patients with cardiac disease. *J Cardiopulm Rehabil* 1987; 7:402-440.
21. Squires RW, Muri AJ, Anderson LJ, Allison TG, Miller TD, Gau GT: Weight training during Phase II (Early Outpatient) cardiac rehabilitation. *J Cardiopulm Rehabil* 1991; 11:360-364.
22. Verrill DE: Resistive exercise training in cardiac rehabilitation. *ACSM Certified News* 1996; August:1-7.

23. Parker ND, Hunter GR, Treuth MS, et al: Effects of strength training on cardiovascular responses during a submaximal walk and weight-loaded walking test in older females. *J Cardiopulm Rehabil* 1996; 16:56-62.
24. American Association of Cardiovascular and Pulmonary Rehabilitation: Guidelines for Cardiac Rehabilitation Programs, ed. 4. Champaign, IL: Human Kinetics, 1995.
25. American College of Sports Medicine: Guidelines for Exercise Testing and Prescription, ed. 4. Philadelphia: Lea & Febiger, 1991.
26. Fletcher GF, Balady G, Froelicher VF, Hartley LH, Haskell WL, Pollock ML: Exercise standards-A statement for healthcare professionals from the American Heart Association. *Circulation* 1995; 91: 580-615.
27. Fragnoli-Munn K, Savage PD, Ades PA: Combined resistive-aerobic training in older patients with coronary artery disease early after myocardial infarction. *J Cardiopulm Rehabil* 1998; 18:416-420.
28. Berg WP, Lapp BA: The effect of a practical resistance training intervention on mobility in independent, community-dwelling older adults. *J Aging Phys Act* 1998; 6:18-35.
29. Beniamini Y, Rubenstein JJ, Faigenbaum AD, Lichenstein AH, Crim MC: High-intensity strength training of patients enrolled in an outpatient cardiac rehabilitation program. *J Cardiopulm Rehabil* 1999; 19:8-17.
30. McCartney N, McKelvie RS, Haslam DRS, Jones NL: Usefulness of weightlifting training in improving strength and maximal power output in CAD. *Am J Cardiol* 1991; 67:939-945.
31. Wilke NA, Sheldahl LM, Levandoski SG, Hoffman MD, Dougherty SM, Tristani FE: Transfer effect of upper extremity training to weight carrying in men with ischemic heart disease. *J Cardiopulm Rehabil* 1991; 11:365-372.
32. Lichenstein MJ, Shields SL, Shiavi RG, Burger C: Exercise and balance in aged women: A pilot controlled clinical trial. *Arch Phys Med Rehabil* 1989; 70:138-143.
33. Podsiadlo D, Richardson S: The timed "Up & Go": A test of basic functional mobility for frail elderly persons. *Am Geriatr Soc* 1991; 39:142-148.

34. Schroeder JM, Nau KL, Osness WH, Potteiger JA: A comparison of life satisfaction, functional ability, physical characteristics, and activity level among older adults in various living settings. *J Aging Phys Activ* 1998; 6:340-349.
35. Brill PA, Mathews M, Mason J, Davis D, Mustafa T, Macera C: Improving functional performance through a group-based free weight strength training program in residents of two assisted living communities. *Phys Occ Ther Geriatr* 1998; 15:57-69.
36. Fiatarone MA, O'Neill EF, Ryan ND, et al: Exercise training and nutritional supplementation for physical frailty in very elderly people. *New Eng J Med* 1994; 330:1769-1775.

APPENDIX A
INFORMED CONSENT

Informed Consent

Effects of Resistance Training on Females with Cardiac Disease

I, _____ (print name), voluntarily consent to participate in a study to investigate the effects of a 10-week resistance training program on muscular strength and functional abilities. As a participant in this study, I will be randomly assigned to either a control or experimental group. If I am assigned to the experimental group, I will undergo a series of muscular strength and functional ability tests and participate in a 10-week moderate intensity weight training program. If I am assigned to the control group, I will participate in the muscular strength and functional ability testing only. Testing for the control and experimental groups will require two, one hour sessions at the beginning and end of the study period.

Testing

I have been informed that all testing and training will be scheduled in the Physical Therapy Department (across the hall from Cardiac Rehab) at Franciscan Skemp Healthcare. Participants will be tested for maximal strength (the most weight which can be lifted once) before and after the training program on the following exercises:

1. Triceps extension	6. Chest press
2. Biceps curl	7. One arm pull
3. Leg press	8. Shoulder press
4. Leg extension	9. Calf raises
5. Leg curl	

Functional testing is required for all participants as well and will take place on a separate day. The majority of the functional tests will be timed and will evaluate the performance of common activities of daily living such as:

1. Chair sit-to-stand	5. Single leg stand
2. Floor rise	6. Functional reach
3. Up-and-go	7. Step test
4. Grocery carry	

Training

The training program will be 10 weeks in duration, meeting on Monday, Wednesday, and Friday mornings in the Franciscan Skemp Healthcare Physical Therapy Department. Each session will last approximately one hour, and will include the weight training exercises described above. The workload of the exercises will be individually determined from the initial strength testing. Initially, training will include performing

two sets of 12-15 repetitions on each exercise. The weight load will progressively increase, resulting in a decrease in the number of repetitions (i.e., two sets of 8-10 repetitions).

I have been informed that all testing and training sessions will be scheduled at my convenience and will be conducted by Stefanie Hatcher (784-9896) and Carla Theusch (787-0696), graduate students from the University of Wisconsin-La Crosse Adult Fitness/Cardiac Rehabilitation program. These students are under the supervision of John P. Porcari, Ph.D. If any questions arise during the testing or training, Dr. Porcari can be contacted at (608) 785-8684.

I have been informed that the following benefits are often associated with a properly performed resistance training program: increased muscular strength and endurance, reduced percent of body fat, increased self-confidence, increased self-image, decreased resting blood pressure, decreased insulin requirement, increased bone density, and increased ability to perform activities of daily living (walking, carrying groceries, etc.).

I have also been informed that there are possible risks and discomforts associated with participating in any exercise testing and training program. These include musculoskeletal injuries and possible irregularities in heart beat, heart rate, blood pressure, and heart rhythm. Dizziness, lightheadedness, syncope, heart attack, stroke, or death are also possible risks. Every effort will be made to minimize these risks by evaluation of my previous medical and exercise history. I have been instructed to report any signs and symptoms, or other discomforts that occur during testing or training to the researchers. Permission will also be obtained from my personal physician before I participate in the study. In addition, trained personnel and emergency equipment are available if an emergency situation should arise. I also understand that Franciscan Skemp Healthcare will not be held liable for any adverse consequence that may occur and my personal medical insurance will be responsible for all necessary coverage.

I consent to the publication of the results of this study so long as the information is anonymous and disguised so that no identification of individual subjects can be made. I have been informed that although a record will be kept of my participation in this study, all data collected from my participation will be identified by number only.

I consider myself to be in good health and to my knowledge I am not infected with a contagious disease or have any musculoskeletal limitations that would preclude my participation in the described study.

I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by John Porcari Ph.D., 141 Mitchell Hall, UW-L, La Crosse, Wisconsin, 54601, (608) 785-8684. Questions regarding the protection of human subjects may be addressed to Dr. Garth Tymeson, Chair, UW-La Crosse, IRB for the protection of human subjects (608) 785-8155.

I have read the above information. The nature, demands, risks, and benefits of the project have been explained to me. I knowingly assume the risks involved, and understand that I may withdraw my consent and discontinue participation at anytime without penalty or loss of medical care at Franciscan Skemp Healthcare. In signing this form I am waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me for my records.

Signed: _____

Date: _____

Witness: _____

Date: _____

APPENDIX B
PHYSICIAN CLEARANCE

University of Wisconsin-La Crosse
La Crosse, WI 54601

Title: The Effects of Resistance Training on Females with Cardiac Disease.

Principle Investigators: Stefanie Hatcher and Carla Theusch

Dear Dr. _____,

We are writing to ask your permission to allow your patient _____ to participate in a moderate intensity resistance training program. The study to be conducted will be our master's theses for the Adult Fitness/Cardiac Rehabilitation program.

The purpose of the study is to investigate the effects of a 10-week resistance training program on muscular strength and endurance and functional abilities of female Phase III cardiac rehabilitation participants. Few studies have been done that specifically target the female cardiac patient in regards to resistance training and functional abilities. The results will be used by Franciscan-Skemp Healthcare to determine if resistance training will be implemented into their current cardiac rehabilitation program.

Each subject participating in the study will be randomly assigned to a control or experimental group and will continue with their current exercise prescription. The experimental group will undergo a series of muscular strength and functional ability tests and participate in a 10-week moderate intensity resistance training program. The control group will participate in the muscular strength and functional ability testing only. Testing will require two, one-hour sessions at the beginning and end of the study. One week of orientation will be included to allow the participants to become acquainted with proper lifting and breathing techniques. All subjects in the control and experimental groups will complete informed consent forms. These will be collected at the Franciscan-Skemp Healthcare cardiac rehabilitation office before any participation in the experiment, including orientation week, has begun.

Testing

The majority of the functional tests will be timed and will evaluate the performance of common activities of daily living such as:

1. Chair sit-to-stand	5. Single leg stand
2. Floor rise	6. Functional reach
3. Up-and-go	7. Stair climb test
4. Grocery carry	

Training

The training program will be 10 weeks in duration, meeting on Monday, Wednesday, and Friday mornings. Each session will last approximately one hour, and will include the weight training exercises described below:

1. Triceps Extension	6. Chest Press
2. Biceps Curl	7. Shoulder Press
3. Leg Press	8. Calf Raises
4. Leg Extension	9. One Arm Pull
5. Leg Curl	

The workload of the exercises will be individually determined from the initial strength testing. Initially, training will include performing two sets of 12-15 repetitions at 50% 1-RM on each exercise. The weight load will progressively increase, resulting in a decrease in the number of repetitions (i.e. two sets of 8-10 repetitions).

Each testing and training session will be supervised and emergency equipment will be available if an emergency situation should arise. Each subject will be made aware of the possible risks involved and will be instructed to report to us any signs, symptoms or other discomforts that occur during testing or training. The orientation will be used to familiarize the subjects with the equipment and proper lifting procedures. An emphasis will be placed on proper breathing techniques to avoid any adverse cardiovascular changes. Previous literature has shown resistance training to be very safe and effective for cardiac patients when executed properly.

The possible benefits to a resistance training program are: increased muscular strength and endurance, reduced percent of body fat, increased self-confidence, increased self-image, decreased resting blood pressure, decreased insulin requirement, increased bone density, and increased ability to perform activities of daily living (walking, carrying groceries, etc.).

I give my permission for my patient _____, to participate in the
aforementioned resistance training study.

Dr. _____

Date _____

Please return this signed form to the Cardiac Rehabilitation Office of Franciscan-Skemp Healthcare, La Crosse, WI, as soon as possible. Thank you.

APPENDIX C
SUBJECT INFORMATION SHEET

Subject Information

Name _____

Number _____

Address _____

Phone _____

Age _____

Ht. _____

Wt. _____

Type of Disease _____

Medications _____

Start Date of Rehab _____

Current Ex Prescription _____

APPENDIX D

REVIEW OF RELATED LITERATURE

LITERATURE REVIEW

The elderly population is growing and looking for ways to improve, or maintain their quality of life. The ability to perform everyday activities is a large component of independence and in turn, quality of life. The aging process has adverse effects on the ability to perform daily activities, and research has focused on ways to decrease the effects of aging and improve function. Recently, an increased awareness of the importance of studies including women has taken place. Women are at an increased risk of losing function due to their overall lower level of strength and longer life expectancy. This review will discuss the literature relative to the effects of muscular weakness and chronic disease on physical function of women.

Muscular Weakness and Functional Performance

Aging has been shown to have adverse effects on muscle mass, strength, and endurance, as well as changes in balance and body composition.^{1,2} In an overview of previous literature, Chandler and Hadley³ found that lower extremity weakness was associated with a decrease in functional performance measures in healthy older men and women. Numerous studies have also been completed on balance and gait, and their relationships with lower body strength.⁴⁻⁷

Balance plays a large role in the mobility of older adults, and a loss of balance may result in an increased risk for falls, injury, and a loss of independence.² It is now understood that a large portion of the loss in muscular strength and endurance with aging

can be attributed to lack of activity, not only the adverse effects of aging. The effects of training programs on strength and function have shown mixed results.

Exercise Training and Function in Older Adults

Studies have tested the effects of a variety of training protocols on functional outcomes. Training protocols range from the use of exercise bands, rice bags, and home exercise programs, to high intensity resistance training (RT). Functional outcomes studied have included gait and mobility, balance, muscular strength and endurance, and measures of activities of daily living (ADL's).

One of the most highly publicized studies on resistance training, strength, and functional performance was conducted on frail elderly men and women.⁸ This was one of the first resistance training studies done on frail adults over the age of 90 (mean age 90.2). The 8 week program concentrically and eccentrically trained knee extensor muscles. The results showed increases in muscle strength (174%), as well as thigh muscle area (9%), and gait speed (48%).

Another study done by Fiatarone et al.⁹ found that high-intensity RT could also improve strength and function in frail men and women over age 70. Muscular strength increased by 113%, improvements in stair climb power was 28.4%, and gait velocity improved by 11.8%. Although these studies were done on the very frail elderly, many studies have shown improvements in less disabled, community dwelling adults.

A year long exercise training study on community dwelling older women (mean age 71.6), used various activities aimed at improving strength, endurance, coordination, balance, and flexibility.⁶ The training consisted of aerobic and strengthening exercises,

along with more specific activities for balance, flexibility, muscular endurance, and coordination. Aerobic exercise encompassed dynamic movements to strengthen all major muscle groups. Balance and coordination activities included standing on one leg, ball games, and skipping rope. Strength gains were significant in all lower body exercises, with a 14% improvement after 22 weeks and 16.2% improvement after one year. Balance, measured by postural sway, improved a total of 8% after one year.

A 10 week study on older males and females (mean age 77.6), studied the effects of lower extremity RT using exercise bands and body weight.¹⁰ Training included lower extremity strengthening exercises, along with specific chair-rise and stair-stepping stations. Significant improvements in strength (10-16%) led to improvements in gait, stooping, and stair climbing. Improvements were also seen in the chair-rise, but only in initially low-level individuals. No significant changes occurred in the 6-minute walk, functional reach, or postural sway.

Three studies ranging from 12-16 weeks found favorable outcomes in older females from exercise training.¹¹⁻¹³ All found significant improvements in strength and walking endurance in their trained subjects. Hunter et al.¹² found that dynamic strength increased 52%, walking velocity increased 18%, and EMG of the rectus femoris (while standing), decreased by 40%. EMG changes were also found to decrease 36% in the biceps during a weight-loaded walking test. Ades and associates¹¹ found that submaximal walking endurance improved 38% in the males and females, with the majority of improvement seen in the male subjects. The females improved significantly in the leg extension, leg flexion, and bench press, while the males' only significant improvement

was in the leg extension. Parker et al.¹³ found that their trained subjects had a 57% improvement in strength, total treadmill time increased by 15%, and rate pressure products were lower during submaximal (7%) and weight-loaded (17%) walking tests.

In a training study designed to increase balance in older women (mean age 68), the effects of two different training protocols were investigated.¹⁴ One group participated in lower body strength training, walking, and postural control exercises, while the second group only participated in the postural control exercises. The study concluded that a combination of exercises, including specific balance training, could improve leg press force (21%), single-leg-balance times (18%), and decrease postural sway in older women.

Another study looked at balance and the prevalence of falls in community dwelling older women (mean age 72.4).⁷ The training included specific exercises to improve strength, balance, gait, and mobility. Losses in strength were found in the control group over the 12-month period, but no changes were seen in the experimental group. Gait velocity was not noticeably different between the experimental (1.10 meters/second) and control (1.16 meters/second) groups, but one-leg stand time improved from 13.9 ± 2.3 to 14.7 ± 2.3 seconds in the experimental group while the control group declined. There were no significant changes in the incidence of falls, however. The authors felt that the intensity of the exercise may not have been enough to improve function in the healthy population over the year long program.

A common explanation in the literature for the lack of functional improvements was the intensity of the training used. Berg and Lapp¹⁵ studied the effects of a lower extremity training program using ankle weights on community dwelling male and female

subjects (mean age 72.9). Although the mean weight used for the exercises improved by 63% for the men and women of the experimental group, improvements in function were not found. Gait velocity actually decreased 1.6% and the agility score only improved 0.3%. The authors felt that the low intensity exercises were not adequate or specific enough to elicit significant changes in functional performance measures.

Other studies found the specificity of the RT to be an issue.^{10,16,17} A 12 week study conducted on older women (mean age 79.5) using one supervised and two home sessions a week included strength exercises using body weight, rice bags, and exercise bands for resistance.¹⁷ The results included moderate increases in strength (4-27%) however, there were few improvements in any of the 14 functional tests. Only the step height (5%) and kneel rise (21%) tests showed improvement. It was felt that small, isolated changes in strength and power were not adequate enough to change the values of the specific functional tests used.

Exercise Training and Functional Performance of Diseased Populations

The previously discussed studies excluded many subjects due to diseases that may affect the outcomes. This eliminates a large portion of the older adult population that is in need of strength improvements. Many chronic diseases, such as cardiovascular disease (CVD), require the adult to be dependent on a variety of medications. Many of these medications may lead to an increase in muscular weakness and atrophy.⁴ The diseases themselves may also limit the amount of physical activity the adult participates in. The combination of lack of activity and medication use puts diseased populations at an increased risk for low functional performance and loss of independence.⁴

Women with CVD are at an increased risk of disability, more so than men, for two main reasons. First, due to their overall lower level of strength, and second because CVD becomes symptomatic later in life (post-menopausal) for females.¹⁸ Little research has been published on the effects of exercise training and functional performance of men or women with CVD. Resistance training (RT) was felt to increase the workload of the heart in an unsafe manner. It is now widely known that when executed properly, RT is safe and often recommended to improve functional performance.¹⁹⁻²³

A 10-week RT study conducted by McCartney, et al.²⁴ on males with CVD found improvements in cycling performance. Maximal power on a cycle ergometer improved by 15% in the RT group compared to the control group. Muscular endurance also improved on the cycle ergometer with an 11% increase in the time to fatigue, indicating an increased aerobic tolerance in the RT subjects. Subjects also had lower rating of perceived exertion (RPE) at similar workloads after training.

Similar outcomes were found in a 12-week high-intensity RT program that included men and women.¹⁹ The training consisted of four exercises performed initially at 50% 1-RM, two times a week, and progressed to 80% 1-RM. Endurance and maximal treadmill time improved 39% in the trained subjects when compared to the control subjects' improvement of 18%. The trained subjects were also able to increase their mean maximum heart rate (HR) without symptoms, and decrease their RPE at any given workload.

Similar decreases in HR response were found by Wilke et al.²¹ on men with ischemic heart disease. Subjects who exercised for 12-weeks on a circuit weight training

(CWT) program had significant strength improvements of 30% for the upper body and 35% for the lower body. CWT subjects had lower HR responses and were able to carry more weight during a weight-loaded walking test. Maximal VO_2 (ml/kg/min) from a cycle ergometer test also improved significantly ($p < 0.05$) from 21.53 ± 3.5 to 24.86 ± 4.82 in the CWT subjects.

Conclusion

There is limited research on cardiac populations, which investigates changes in functional measures. The loss of functional performance with age is exacerbated by CVD. Previous training studies have failed to include subjects with disease even though they are a large portion of the population in need of functional improvements. Previous studies on healthy, older males and females have used different training methods, modalities, and intensities resulting in a variety of strength and functional changes. Without a proven exercise program protocol, researchers are struggling to find proper activities and intensities that will elicit improvements in functional performance. This study was conducted to fill a void in the literature on strength and function of older women with CVD.

REFERENCES

1. Booth FW, Weeden SH, Tseng BS: Effects of aging on human skeletal muscle and motor function. *Med Sci Sports Exerc* 1994; 26:556-560.
2. Kauffmann T: Functional Performance in Older Adults. Philadelphia: Davis, 1994; 42-59.
3. Chandler JM, Hadley EC: Exercise to improve physiologic and functional performance in old age. *Clin Geriatr Med* 1996; 12:761-784.
4. Fiatarone MA, Evans WJ: The etiology and reversibility of muscle dysfunction in the aged. *J Gerontology* 1993; 48:77-83.
5. Lord SR, Castell S: Physical activity program for older persons: Effect on balance, strength, neuromuscular control, and reaction time. *Arch Phys Med Rehabil* 1994; 75:648-652.
6. Lord SR, Ward JA, Williams P, Strudwick M: The effects of a 12-month exercise trial on balance, strength, and falls in older women: A randomized controlled trial. *J Am Geriatr Soc* 1995; 43:1198-1206.
7. MacRae PG, Felner ME, Reinsch S: A 1-year exercise program for older women: Effects on falls, injuries, and physical performance. *J Aging Phys Activ* 1994; 2:127-142.
8. Fiatarone MA, Marks EX, Ryan ND, Meredith CN, Lipisitz LA, Evans WJ: High-intensity strength training in nonagenarians: Effects on skeletal muscle. *JAMA* 1990; 263:3029-3034.
9. Fiatarone MA, O'Neill EF, Ryan ND, et al: Exercise training and nutritional supplementation for physical frailty in very elderly people. *New Eng J Med* 1994; 330:1769-1775.
10. Chandler JM, Duncan PW, Kochersberger G, Studenski S: Is lower extremity strength gain associated with improvement in physical performance and disability in frail, community-dwelling elders? *Arch Phys Med Rehabil* 1998; 79:24-30.
11. Ades PA, Ballor DL, Ashikaga T, Utton JL, Nair KS: Weight training improves walking endurance in healthy elderly persons. *Ann Int Med* 1996; 124:568-571.

12. Hunter GR, Treuth MS, Weinser RL, et al: The effects of strength conditioning on older women's ability to perform daily tasks. *J Am Geriatr Soc* 1995; 43:756-760.
13. Parker ND, Hunter GR, Treuth MS, et al: Effects of strength training on cardiovascular responses during a submaximal walk and weight-loaded walking test in older females. *J Cardiopulm Rehabil* 1996; 16:56-62.
14. Judge JO, Lindsey C, Underwood M, Winsemius D: Balance improvements in older women: Effects of exercise training. *Phys Ther* 1993; 73:254-265.
15. Berg WP, Lapp BA: The effect of a practical resistance training intervention on mobility in independent, community-dwelling older adults. *J Aging Phys Act* 1998; 6:18-35.
16. MacRae PG, Lacourse M, Modavon R: Physical performance measures that predict faller status in community-dwelling older adults. *J Ortho Sport Phys Ther* 1992; 16:123-128.
17. Skeleton DA, Young A, Greig C, Malbut KE: Effects of resistance training on strength, power, and selected functional abilities of women aged 75 and older. *J Am Geriatr Soc* 1995; 43:1081-1087.
18. Nickel JT, Chirikos TN: Functional disability of elderly patients with long-term coronary heart disease: A sex stratified analysis. *J Gerontol* 1990; 45:S60-68.
19. Beniamini Y, Rubenstein JJ, Faigenbaum AD, Lichenstein AH, Crim MC: High-intensity strength training of patients enrolled in an outpatient cardiac rehabilitation program. *J Cardiopulm Rehabil* 1999; 19:8-17.
20. Butler RM, Beirwaltes WH, Rogers FJ: The cardiovascular responses to circuit weight training in patients with cardiac disease. *J Cardiopulm Rehabil* 1987; 7:402-440.
21. Wilke NA, Sheldahl LM, Levandoski SG, Hoffman MD, Dougherty SM, Tristani FE: Transfer effect of upper extremity training to weight carrying in men with ischemic heart disease. *J Cardiopulm Rehabil* 1991; 11:365-372.
22. Squires RW, Muri AJ, Anderson LJ, Allison TG, Miller TD, Gau GT: Weight training during Phase II (Early Outpatient) cardiac rehabilitation. *J Cardiopulm Rehabil* 1991; 11:360-364.

23. Verrill DE: Resistive exercise training in cardiac rehabilitation. *ACSM Certified News* 1996; August:1-7.
24. McCartney N, McKelvie RS, Haslam DRS, Jones NL: Usefulness of weightlifting training in improving strength and maximal power output in CAD. *Am J Cardiol* 1991; 67:939-945.