ORIGINAL ARTICLE

The Effects of a 12-Week Strength-Training Program on Strength and Functionality in Women With Fibromyalgia

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ABSTRACT. Kingsley JD, Panton LB, Toole T, Sirithienthad P, Mathis R, McMillan V. The effects of a 12-week strength-training program on strength and functionality in women with fibromyalgia. Arch Phys Med Rehabil 2005;86: 1713-21.

Objective: To determine whether women with fibromyalgia benefit from strength training.

Design: Randomized controlled trial.

Setting: Testing was completed at the university and training was completed at a local community wellness facility.

Participants: Twenty-nine women (age range, 18–54y) with fibromyalgia participated. Subjects were randomly assigned to a control (n=14; wait-listed for exercise) or strength (n=15) group. After the first 4 weeks, 7 (47%) women dropped from the strength group.

Intervention: Subjects underwent 12 weeks of training on 11 exercises, 2 times a week, performing 1 set of 8 to 12 repetitions at 40% to 60% of their maximal lifts and were progressed to 60% to 80%.

Main Outcome Measures: Subjects were measured for strength, functionality, tender point sensitivity, and fibromyalgia impact.

Results: The strength group significantly ($P \leq .05$) improved upper- (strength, 39±11 to 42±12kg; control, 38±13 to 38±12kg) and lower- (strength, 68±28 to 82±25kg; control, 61±25 to 61±26kg) body strength. Upper-body functionality measured by the Continuous-Scale Physical Functional Performance test improved significantly (strength, 44±11 to 50±16U; control, 51±11 to 49±13U) after training. Tender point sensitivity and fibromyalgia impact did not change.

Conclusions: Strength training improved strength and some functionality in women with fibromyalgia. Interventions with resistance have important implications on independence and quality of life issues for women with fibromyalgia.

Key Words: Activities of daily living; Body composition; Fibromyalgia; Rehabilitation.

FIBROMYALGIA IS THE SECOND most common soft tissue disorder in the United States, afflicting approximately 4 to 6 million Americans, the majority being women.[1] Fibromyalgia is an idiopathic, soft tissue syndrome characterized by chronic pain, chronic fatigue, irritable bowel syndrome, anxiety, depression, and mental fogginess.[1-4] Strength and functionality are lower in patients with fibromyalgia compared with age-matched controls.[5,6] Kingsley et al[7] found that middle-aged women with fibromyalgia had levels of functionality similar to sedentary women 25 years older.

The majority of research examining physical activity interventions performed on persons with fibromyalgia has focused on improving cardiorespiratory fitness levels.[8-11] The idea of using strength training to alleviate symptomology is a recent intervention tool.[12] Strength training was overlooked as an initial treatment for fibromyalgia because it was thought that fibromyalgia was a direct cause of muscle trauma, and strength training would exacerbate the condition of chronic pain and muscle damage.[12] Current research, however, suggests that strength training may slow the cycle of deconditioning and permit fibromyalgia patients to participate in other forms of activities.[13] Although research on the effects of strength training in women with fibromyalgia is limited, some studies have shown improvements in strength,[2-4,8,14-16] decreases in total myalgic score,[4] and decreases in fibromyalgia impact.[15] Most studies have used strength training in combination with aerobic exercise.[4,8,15] No studies have examined the effects of strength training alone on functionality in women with fibromyalgia. This research is especially important because many women with fibromyalgia complain of problems with their routine tasks of daily living. Therefore, we examined the effects of a progressive strength-training program on strength and functionality in women diagnosed with fibromyalgia.

METHODS

Participants

Twenty-nine women diagnosed with fibromyalgia between the ages of 18 to 54 years were recruited through local newspaper advertisement. Women were excluded if they had uncontrolled hypertension, uncontrolled diabetes, active heart disease, and/or were currently participating in a strength-training program. Approval of the study was obtained from the institutional review board for human subjects committee. Subjects provided informed consent prior to testing.

Data Collection

Data were collected over a 2-week period. Subjects came to the laboratory on 3 different occasions and to the strength-training facility on at least 2 occasions. Testing of functionality and strength measures were completed on separate days with at least 72 hours between tests. This was done to prevent fatigue and flare-ups. Body composition, tender point evaluations, and questionnaires on fibromyalgia impact were completed in the same visit. The rheumatologist was the only investigator

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blinded to the group assignments of the women participating in the study.

Strength

Maximal strength measurements for the upper and lower body were performed on the Nautilus chest press and leg extension machines.[a] Subjects were given a warm-up before testing. Once the warm-up was complete, subjects were progressed toward a maximal weight that they could move 1 time (1-RM) through a full range of motion. All measurements were recorded within 3 to 5 attempts. After a minimum of 72 hours, the subjects returned and the 1-RMs were verified. The highest measurement for the upper and lower body from the 2 days of testing was considered the 1-RM.

Body Composition

Body mass index (BMI; in kg/m^2) was calculated by weight (nearest 0.1kg) and height (nearest 0.1cm).[b] Dual-energy x-ray absorptiometry (DXA)[c] was used to assess body composition according to the specifications of Lohman.[17] Transverse scans of the subject's body were made in the anteroposterior position. Scans were made in 0.6- to 1.0-cm intervals over the area being scanned. The standard error for this method of measuring body composition ranges from 2.5% to 3.5%.

Tender Points

The number of tender points and myalgic score were assessed by a board-certified rheumatologist. The rheumatologist rated the sensitivity of the pain on a scale from 0 (no pain) to 3 (withdrawal of the patient from the examiner) to determine myalgic score. The rheumatologist was blinded to the group assignments of the women participating in the study.

Fibromyalgia Impact Questionnaire

The Fibromyalgia Impact Questionnaire (FIQ) was used to assess the impact of fibromyalgia.[18,19] The FIQ consists of 20 questions pertaining to morning stiffness, mood, pain, and the ability to perform activities of daily living (ADLs). Scores range from 0 to 100U, with higher fibromyalgia impact scores signifying greater disease impact. On average, people with fibromyalgia score about 50U, while a severely impacted person may score above 70U.[18] A derived score of the subjective rating of ADLs was calculated from the FIQ. Construct validity has been demonstrated through correlations of FIQ scores for physical impairment, pain, depression, and anxiety with the Arthritis Impact Measurement Scale (r range, .67–.76[20]). Test-retest correlations have ranged from .56 with pain to .95 for the physical function scale.[18]

Physical Function

The Continuous-Scale Physical Functional Performance (CS-PFP) test was developed from data on older adults with a broad range of physical abilities.[21] This test has been shown to have convergent, construct, and face validity for 16 everyday household tasks. It has high reproducibility (r=.97[21]) and is sensitive to change, with an effect size of 0.8.[22] The CS-PFP is specific for physical function and is not related to emotional or mental health or depression.[21] A detailed description of the procedures for the administration of the test is published elsewhere.[21,23] The CS-PFP test is a valid and reliable comprehensive test of physical functional performance.[21] This test measures higher levels of function without having ceiling effects, as well as testing people who cannot perform a task, thus eliminating floor effects.[21] The test is given under standard conditions that will ultimately minimize variance and enhance the ability to detect changes from intervention programs. Functional performance is measured on the CS-PFP by simulating tasks of routine activities. The CS-PFP is based on ordinary routine tasks, performed at maximal effort within the bounds of safety and comfort. Sixteen tasks are administered, and a combination of time, distance, and weight is used to quantify performance. Tasks quantified using both weight and time include: (1) carrying of weight, (2) pouring water from a jug into a cup, (3) carrying weight up and down a simulated bus platform, and (4) carrying groceries. Tasks quantified by time alone include: (1) transferring laundry from a washer to a dryer, (2) putting on and removing a jacket, (3) floor sweeping, (4) vacuuming, (5) making a bed, (6) climbing stairs, (7) getting down and up from the floor, (8) pulling open a fire door, (9) putting a Velcro strap over a shoe, and (10) picking up 4 scarves off the floor. Tasks that are quantified by distance alone include: (1) a 6-minute walk and (2) highest reach. Time was used to calculate speed (1/t), so that higher numbers reflected higher function for each unit of measure (weight, distance, speed). Each task is scaled 1 to 100 according to the following formula:

$$\text{Corrected Score} = (\text{observed score} - \text{lower limit}) / (\text{upper limit} - \text{lower limit}) \times 100$$

The total physical functional performance score (CS-PFP total) is the average corrected score of all tasks. The CS-PFP total can also be broken down into 5 domains representing upper-body strength, upper-body flexibility, lower-body strength, balance and coordination, and endurance.

The laboratory for the administration of the CS-PFP test was set up to adhere to the published dimensions[21] and was administered using the published protocol[22] and a scripted dialog with minor changes tailored to this laboratory. Performance data were scored using the web-based data reduction program.[23] Blood pressure was taken prior to testing. Subjects wore Polar heart rate monitors[d] throughout the test to record heart rates before and immediately after each task. Ratings of perceived exertion (RPEs) were also recorded after each task. An RPE was also taken from the subjects at the end of the entire test to get a subjective level of an overall perceived exertion of the tasks that had been completed. Subjects wore transfer belts during the test to prevent falls.

Strength Training

On completion of pretesting, subjects were randomly assigned by picking a number out of a bag to either a strength or a wait-listed exercise control group. Subjects in the strength group participated in a progressive full body strength-training regime twice a week. The control group was asked to continue their normal activities until the end of the study, at which time they would be given a strength-training routine.

The strength-training sessions consisted of 11 exercises. Six exercises were performed on Nautilus resistance machines, 3 on the Nautilus cable machine, and the remaining 2 exercises were performed using the subject's body weight as resistance. Resistance machine exercises included the chest press, leg extension, standing leg curl, shoulder press, lumbar extension, and abdominal crunch. The cable exercises included low-pulley biceps curl, high-pulley triceps extension, and the mid-pulley standing row. Body weight was used for the standing calf raises and body weight Swiss ball squats. Subjects performed 1 set of 8 to 12 repetitions twice a week. Before and after workouts subjects performed 5 minutes of warm-up and cool-down that included stretching and walking. Subjects be-

Table 1: Subject Characteristics (N=29)

Variables	Control (n=14)	Strength (n=15)
Age (y)	47±4	45±9
Height (m)	1.64±0.06	1.65±0.05
Weight (kg)	87.0±24.9	81.5±18.5
BMI (kg/m^2)	32.0±7.8	30.3±6.4
Fibromyalgia duration (y)	7±5	9±10

NOTE. Values are mean ± SD.

gan training at 40% of their 1-RM. Once 12 repetitions were performed with proper form, weight was increased by 2.3 to 4.5kg (5–10lb). The duration of each session was approximately 30 minutes. Subjects in the control group were asked not to change their activity levels during the 12-week intervention period. After the 12 weeks of training or control periods, both groups performed on all the above tests again. Investigators were blinded to pretest scores of the women to prevent bias in posttesting.

Data Analyses

One-way analysis of variance (ANOVA) was used to determine if there were initial differences in baseline data. Dependent variables were analyzed by a 2-way (group by time) ANOVA with repeated measures on the last factor. When interactions were significant, 1-way ANOVAs were used to compare pre- and posttest values within groups. Data are presented as means ± standard deviations (SDs). All significance was accepted at P equal to or less than .05. All analyses were performed using the SPSS, version 10, statistical package.[e]

An intention-to-treat (ITT) analysis was used to evaluate pre- and posttest scores to address the effects of the intervention on the subjects whether or not they completed the study. Using the principle of last observation carried forward, missing posttest scores were filled using the test scores that were collected closest to the time of dropout. All dropouts occurred within the first 4 weeks of the study, therefore pretest values were used for the subjects' posttest scores. Secondary analyses included tests to determine whether the interventions were effective for those subjects who completed the study.

RESULTS

Subject Characteristics

Table 1 presents subject characteristics of the initial 29 subjects. Of the initial 29 subjects, 20 (69%) subjects completed the study, 12 of 14 in the control group and 8 of 15 in the strength group. Figure 1 represents participant progress through the study. Two control subjects did not complete the study—one due to surgery for her parathyroid gland and the other did not return phone calls for posttesting. Seven (47%) of the 15 subjects randomized to the strength group also did not

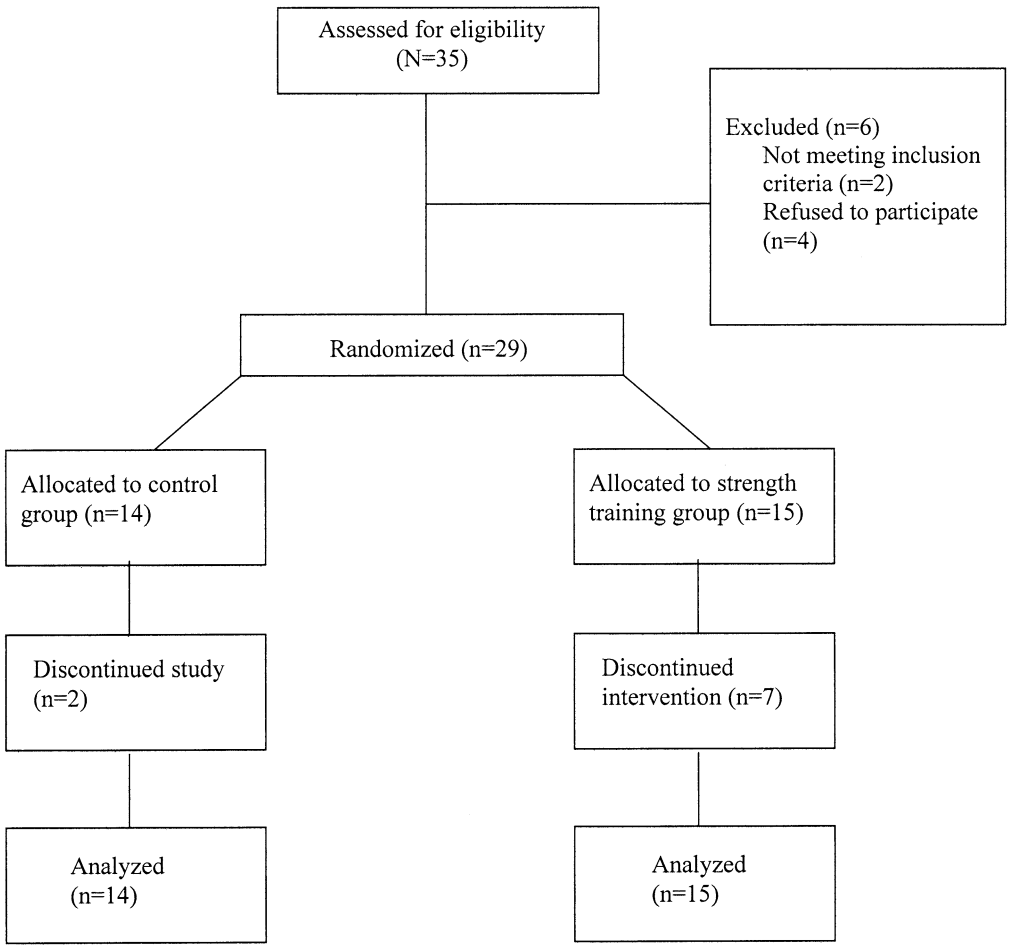

Fig 1. Flow diagram of the progress of subjects through the study.

Table 2: Strength, Body Composition (DXA), Total Tender Point, Total Myalgic, FIQ, and Self-Reported ADL Measurements Before and After 12 Weeks of Strength Training in Women With Fibromyalgia for the ITT Analysis (N=29)

Variable	Control (n=14)		Strength (n=15)	
	Pre	Post	Pre	Post
Chest press (kg)	38±13	38±12	39±11	42±12*†
Leg extension (kg)	61±25	61±26	68±28	82±25*†
Body weight (kg)	87.0±24.9	87.9±24.9	81.5±18.5	82.1±17.9
Lean mass (kg)	44.3±8.6	44.8±8.5	41.6±5.9	41.5±5.5
Fat mass (kg)	37.9±16.6	38.2±16.4	35.9±13.2	36.3±12.9
BMD (g/cm^2)	1.20±0.10	1.20±0.10	1.21±0.07	1.21±0.07
Body fat (%)	42.7±9.1	42.7±9.1	43.5±7.2	43.8±7.0
Total tender points	12±6	12±5	12±5	11±5
Myalgic score (U)	14±8	13±6	16±7	14±7
FIQ (U)	57.1±12.2	53.9±13.2	60.8±19.9	54.6±19.9
SADLs (U)	3.9±1.4	3.1±1.9	4.4±2.6	4.1±2.4

NOTE. Values are means ± SD.
Abbreviations: BMD, bone mineral density; SADLs, self-reported ability of ADLs.
*$P \leq .05$, significantly different from control.
†$P \leq .05$, significantly different from pretest.

complete the study. One subject was diagnosed with reflex sympathetic disorder in her foot and wrist, another subject never started strength training, one stopped training due to military responsibilities, and another stopped attending due to severe depression and could not drive in the evening after work to exercise. One subject had a flare-up but was also having problems before starting the study and had already missed 6 weeks of work, one had surgery for polyps, and one had an anxiety disorder so severe that training sessions were impossible for her to complete. The 9 participants who did not complete the study were similar to the participants completing the study in all measured parameters (age, height, weight, disease duration, BMI, percentage of body fat, upper-body strength, number of tender points, myalgic score, functionality). The noncompleters were significantly stronger in lower-body strength (noncompleters, 81.8±33.9kg vs completers, 56.6±17.7kg). There was also a tendency ($P=.063$) for the noncompleters (68±12U) to have a higher FIQ score than the completers (55±17U). Of the women who completed the study in both the control and strength groups, there were no differences ($P>.05$) in any of the baseline values. Most of the women were middle aged (46±7y), had suffered with fibromyalgia for 8±7 years, and were overweight (BMI, 31.1±7.0kg/m^2).

Strength-training levels, for upper and lower body, began at an intensity of approximately 30% and 40%, respectively, of the subject's initial 1-RMs and progressed to 60% and 80% of the initial 1-RMs by week 12. No injuries were reported during training.

ITT Analyses

Table 2 presents the ITT analysis for the strength measurements. There were significant differences in lower- ($F_{1,1,27}=9.6$, $P \leq .05$, effect size [ES]=.26) and upper- ($F_{1,1,27}=4.3$, $P \leq .05$, ES=.14) body strength between the 2 groups for 1-RM measurements after 12 weeks. One-way ANOVA showed a significant pre to post increase for the strength group in both upper- ($F_{1,14}=6.8$, $P \leq .05$, ES=.33) and lower- ($F_{1,14}=12.2$, $P \leq .05$, ES=.47) body strength. Although there were significant increases in upper- and lower-body strength for the strength group, there were no subsequent changes in total body weight, lean body mass, fat mass, percentage of body fat, or bone mineral density (see table 2).

Table 2 also presents the data for the number of tender points, total myalgic score, scores for the FIQ, and the scores for the FIQ subscale for the self-reported ADLs. After 12 weeks of training there were no significant differences among these variables between the control and strength groups. The baseline data indicated that the women in this study had an average of 12±5 active tender points with a myalgic score of 15±7U and an average fibromyalgia impact score of 59±17U.

Table 3 presents the ITT analyses for the functionality data. There were significant differences between the 2 groups for the upper-body strength domain ($F_{1,1,27}=6.5$, $P \leq .05$, ES=.19) and the overall RPE that subjects felt after completing all the tasks in the CS-PFP test ($F_{1,1,27}=4.2$, $P \leq .05$, ES=.13). One-way ANOVA showed a significant pre to post increase for the strength group in the upper-body strength domain ($F_{1,14}=7.1$, $P \leq .05$, ES=.34) and in the RPE ($F_{1,14}=4.8$, $P \leq .05$, ES=.26) after training.

Secondary Analyses of the Completers

Table 4 presents the strength and functionality measurements of subjects who completed the study. There were sig-

Table 3: CS-PFP Test Domains Before and After 12 Weeks of Strength Training in Women With Fibromyalgia for the ITT Analysis (N=29)

Variable	Control (n=14)		Strength (n=15)	
	Pre	Post	Pre	Post
UBS	51±11	49±16	44±11	50±16*†
UBF	68±11	68±17	67±15	71±16
LBS	46±16	50±17	38±16	46±21
BALC	50±15	55±16	45±18	51±20
END	56±16	59±17	49±18	55±21
CS-PFP total	52±14	55±16	46±16	52±19
Overall RPE	12±2	12±2	12±2	11±3*†

NOTE. Values are mean units ± SD.
Abbreviations: BALC, balance and coordination domain; END, endurance domain; LBS, lower-body strength domain; UBF, upper-body flexibility domain; UBS, upper-body strength domain.
*$P \leq .05$, significantly different from control.
†$P \leq .05$, significantly different from pretest.

Table 4: Strength Measurements and CS-PFP Test Domains Before and After 12 Weeks of Strength Training in Women With Fibromyalgia Who Completed the Study (n=20)

	Control (n=12)		Strength (n=8)	
Variable	Pre	Post	Pre	Post
Chest press (kg)	39±11	38±10	41±10	44±11*†
Leg extension (kg)	59±18	59±20	53±18	79±24*†
UBS	50±11	49±13	47±10	59±14*†
UBF	67±11	67±18	73±13	82±6
LBS	44±15	49±16	43±15	60±16*†
BALC	50±14	55±15	54±17	64±15
END	55±16	59±17	57±17	68±14†‡
CS-PFP total	51±14	55±15	52±15	65±13*†
Overall RPE	12±1	13±2	11±2	10±3*†

NOTE. Values are mean units ± SD.
*$P \leq .05$, significantly different from control.
†$P \leq .05$, significantly different from pretest.
‡$P = .06$, significantly different from control.

nificant differences between the strength and control groups in lower ($F_{1,1,18}=40.1$, $P \leq .05$, ES=.69) and upper ($F_{1,1,18}=7.5$, $P \leq .05$, ES=.30) body strength. The strength group also had significant pre- to posttest increases in both upper- ($F_{1,7}=11.1$, $P \leq .05$, ES=.61) and lower- ($F_{1,7}=48.8$, $P \leq .05$, ES=.87) body strength. There were also significant differences between the groups for the functionality measurements of upper-body strength domain ($F_{1,1,18}=12.5$, $P \leq .05$, ES=.41), lower-body strength domain ($F_{1,1,18}=8.4$, $P \leq .05$, ES=.32), total functionality score ($F_{1,1,18}=6.6$, $P \leq .05$, ES=.27), total RPE ($F_{1,1,18}=5.4$, $P \leq .05$, ES=.23), and a trend for a significant difference in the endurance domain ($F_{1,1,18}=4.0$, $P=.06$, ES=.18). The strength group had significant improvements from pre- to posttests in the functionality domains of upper-body strength ($F_{1,7}=11.9$, $P \leq .05$, ES=.63), lower-body strength ($F_{1,7}=21.3$, $P \leq .05$, ES=.75), and endurance ($F_{1,7}=12.9$, $P \leq .05$, ES=.65), as well as in total functionality ($F_{1,7}=16.4$, $P \leq .05$, ES=.70) and RPE ($F_{1,7}=6.5$, $P \leq .05$, ES=.48) after training.

When evaluating the raw measurements from the CS-PFP test for just the completers, there were significant increases in the amount of weight carried in some of the tasks, decreases in time to complete tasks, and no significant increases in cardiovascular function measured by heart rate in the different tasks compared with the control group (table 5). RPEs for the individual tasks also did not change with the increases in weight carried or improvement in time. In some of the tasks, RPEs decreased after training compared with the controls.

DISCUSSION

This is the first study to evaluate the effects of a progressive strength-training program on functionality of routine tasks of daily living in women with fibromyalgia. This study supports the hypothesis that strength training can be used as an intervention tool to improve strength and some components of functionality in women diagnosed with fibromyalgia. Women diagnosed with fibromyalgia demonstrate lower muscle strength[6,24] and endurance.[10,15] These symptoms result in exercise intolerance and limitations in the ability to perform routine tasks of daily living.[5-7]

The increases in strength in the present study for the upper and lower body were 7.7% and 20.6%, respectively. For the women who completed the study the percentage increase for upper- and lower-body strength was 7.3% and 49%, respectively. Although the strength increase in upper body was significant compared with the control group, the percentage increase was small compared to the increases in lower-body strength. One reason for the small strength increases in upper body may have been due to the chest press machine used in this study. Many of our subjects had problems positioning their shoulders and arms to initiate the movement of the machine. Most of the women also had significant pain at the bases of their necks and upper arms, which made completing upper-body exercises difficult, another reason why the training intensity was lower for the upper (60%) compared with the lower (80%) body.

The significant changes in strength in the present study were not accompanied by changes in lean body or fat mass. Reasons for the lack of significance may be due to the moderate training intensity and the short duration of the study (12wk). Häkkinen et al[14] examined the cross-sectional area (CSA) of the thigh after a high-intensity, 21-week, strength program in women with fibromyalgia and found increases in the CSA of the quadriceps femoris after training. Some studies have demonstrated that, in women with fibromyalgia, basal levels of growth hormone (GH) may be lower following an exercise bout.[25,26] These lower GH levels may impede recovery and muscle anabolism in persons with fibromyalgia. However, in Häkkinen's study,[14] the data suggested that skeletal muscles of the women with fibromyalgia retained the capacity to hypertrophy with strength training to the same extent as healthy controls. More research is needed in this area to determine if women with fibromyalgia do have the ability to increase lean body mass with training programs.

This is among the first studies to utilize a valid and reliable tool to evaluate functionality in women diagnosed with fibromyalgia. A study comprised of men and women 65 to 97 years found that a CS-PFP total score of less than 58U may affect the ability to live independently.[27] In the present study, the total score for the CS-PFP test for the women with fibromyalgia was below the 58-U threshold to live independently for both the women in the control (52±14U) and strength (46±16U) groups. Seventy-two percent of the women with fibromyalgia were functioning below this 58-U threshold. Many of them had made modifications in their routine tasks of daily living. Some of the women had made alterations in their kitchens so they did not have to reach above their shoulders to get items from cabinets. Household members were also helping many of these women with housework and with shopping. Following training, the mean for the total CS-PFP score for the strength group increased but did not go above the threshold (52±19U) in the ITT analyses. However, when evaluating the women who completed the study and did the required strength training, these women did have significant improvements in the scores of total functionality as well as in the domains of upper- and lower-body strength. The total functionality of the strength group increased above the threshold (65±13U) while the control group remained below the threshold (55±15U) of living independently.

For the women who completed the strength training there were no changes in upper-body flexibility or balance and coordination compared with the control group. Because the strength-training protocol did not focus on flexibility or balance, changes were not expected in these domains. There was, however, a trend ($P=.06$) for the strength group to differ significantly from the control group in the domain of endurance, which was not expected. There was an 11-m increase in the distance walked by the intervention group. Other studies in women with fibromyalgia have reported increases in six-minute walk distance (6MWD) from 5[28] to 72m[29] with exercise programs. A study by Rooks et al,[15] which combined strength

Table 5: CS-PFP Tests Before and After 12 Weeks of Strength Training in Women With Fibromyalgia Who Completed the Study (n=20)

	Control (n=12)		Strength (n=8)	
Task	Pre	Post	Pre	Post
Pan carry				
HR (beats/min)	86±17	93±12	92±13	91±14
Time (s)	3.9±1.3	3.7±1.0	3.7±1.1	3.5±1.0
Weight (kg)	9.4±4.2	8.3±3.4	7.6±2.8	10.8±4.9*†
RPE	10±3	11±2	8±3	8±2
Water pour				
HR (beats/min)	84±14	91±15	89±14	86±15
Time (s)	8.7±2.3	8.0±2.1	9.0±4.0	7.9±2.9
RPE	8±2	9±2	7±1	7±2
Jacket				
HR (beats/min)	87±15	95±15	93±14	93±15
Time (s)	12.6±3.3	12.1±2.5	11.6±1.9	10.0±1.2
RPE	7±2	8±2	6±1	6±1
Shoe strap				
HR (beats/min)	79±9	90±13	85±13	80±17*
Time (s)	7.3±2.1	6.5±1.9	6.9±1.9	5.1±1.1
RPE	8±2	9±3	7±1	6±1
Scarves				
HR (beats/min)	88±12	97±12	90±15	91±18
Time (s)	9.4±4.5	7.7±2.5	7.5±3.1	5.8±1.3*
RPE	9±2	9±2	7±2	7±1
Reach				
HR (beats/min)	87±15	92±14	90±15	95±20
Height (cm)	211.8±9.4	211.3±9.0	211.6±9.1	209.2±16.5
RPE	10±2	10±2	8±2	8±2
Sweep				
HR (beats/min)	93±14	99±15	94±14	94±19
Time (s)	31.7±14.0	29.4±9.6	30.9±13.7	25.2±9.9
RPE	11±2	10±3	9±2	8±3
Laundry 1				
HR (beats/min)	91±15	101±17	98±16	100±19
Time (s)	27.9±9.2	25.9±8.8	27.9±7.5	24.3±4.7
RPE	11±1	10±2	10±2	8±2†*
Laundry 2				
HR (beats/min)	92±14	98±14	100±11	96±20
Time (s)	19.6±4.8	18.2±6.2	20.4±5.4	16.5±3.9
RPE	10±2	10±2	9±2	8±2
Bed making				
HR (beats/min)	107±20	117±16	113±17	117±26
Time (s)	78.0±24.9	64.8±19.6	81.4±25.8	72.4±23.9
RPE	12±2	12±3	11±3	9±2
Vacuum				
HR (beats/min)	99±15	104±15	103±14	104±21
Time (s)	52.5±16.1	40.0±13.5	48.5±11.0	33.3±7.1
RPE	11±1	11±2	12±3	9±3*
Floor sit				
HR (beats/min)	95±17	106±16	99±16	107±21
Time (s)	11.2±4.0	11.4±4.2	8.8±2.9	6.9±2.1
RPE	12±3	14±3	10±2	10±3*
Fire door				
HR (beats/min)	92±17	97±16	96±18	96±24
Time (s)	2.8±1.1	3.6±1.2	2.5±1.3	2.8±0.7
RPE	8±3	8±2	7±2	6±0.1
Bus stop				
HR (beats/min)	97±11	108±13	102±18	112±24
Time (s)	18.5±4.9	18.6±5.9	18.3±6.9	17.1±2.9
Weight (kg)	8.5±3.5	8.1±4.3	7.5±2.4	13.0±5.1*
Grocery				
HR (beats/min)	105±20	119±11	107±16	121±25

Table 5 (Cont'd): CS-PFP Tests Before and After 12 Weeks of Strength Training in Women With Fibromyalgia Who Completed the Study (n=20)

	Control (n=12)		Strength (n=8)	
Task	Pre	Post	Pre	Post
Time (s)	49.0±9.2	49.3±8.7	49.5±9.3	49.7±7.2
Weight (kg)	7.9±5.8	6.9±5.2	6.4±3.7	10.9±5.2†*
RPE	12±3	13±3	12±1	11±3
6MWD				
HR (beats/min)	112±25	128±19	121±20	118±33
Distance (m)	505.1±99.2	538.3±98.5	484.2±83.2	529.9±85.2
RPE	13±2	14±2	15±3	11±4†*
Stair climb				
HR (beats/min)	97±16	110±12	101±13	108±26
Time (s)	6.3±2.1	6.7±3.5	7.3±3.8	5.8±2.0
RPE	11±2	11±2	10±4	9±3

NOTE. Values are mean ± SD.
Abbreviation: HR, heart rate.
*$P \leq .05$, significantly different from control.
†$P \leq .05$, significantly different from pretest.

training and aerobic exercise, had a 99-m increase in 6MWD. Rooks attributed the large increase in distance walked in part to the increase in muscular strength in their subjects. Therefore, strength training may provide women with fibromyalgia a way to further increase their ability to walk as well as to improve their routine tasks of daily living.

Although the ITT analyses did not show differences in the functionality domains or the total functionality score, it did show improvements in the domain of upper-body strength. This has important implications for women with fibromyalgia who have significant pain and limitations with upper-body movement. The women who strength trained were able to carry more weight in the same amount of time without an increase in heart rate or perceived exertion. In some instances, such as the laundry task and the vacuuming task, the strength-trained subjects' RPEs were significantly lower for those specific tasks. Therefore, strength training may provide women with fibromyalgia a way to increase their ability to perform routine tasks of daily living.

There were no significant differences in the total number of active tender points, myalgic score, and fibromyalgia impact measured by the FIQ after the 12 weeks of training in the strength group compared with the control group for both sets of analyses. The women who completed the training program did not alter their pain medication over the 12 weeks, while 2 women in the control group increased their pain medication. Häkkinen et al[14] saw no change in number of active tender points in women with fibromyalgia who strength trained for 21 weeks. However, Valkeinen et al[30] did show a reduction in number of active tender points after 21 weeks of strength training. Their study had 13 subjects and their number of active tender points went from a mean of 16.5 to a mean of 14.6, a 12% decrease. Another study that combined strength training and walking for 6 weeks also found a significant reduction in number of active tender points, from a mean of 12.8 to 10.2, a reduction of 20%.[4] Rooks[15] found a significant 28% reduction in FIQ score for the women with a combined aerobic and strength program while Martin et al[4] found no change. More research is needed in this area with larger sample sizes to determine whether strength training can help alleviate the pain and the disease impact associated with fibromyalgia.

A portion of the FIQ can be used to assess the subjective ADLs of women with fibromyalgia. In the present study, there were no changes in the subjective measures of ADLs between the 2 groups, although there were some changes in functionality scores measured by the CS-PFP test. It has been shown previously that there may be limitations to self-reported questionnaires of ADLs.[22,31] Questionnaires may not allow subjects to describe subtle changes in ADLs that may be clinically relevant.[31] Another reason women may not self-report a change is that, although they increased strength and some areas of functionality during the training program, they may not have altered their routines at home and were not aware of their increased ability to perform these activities.

When evaluating our results, a couple of limitations need to be addressed. The small sample size and the large attrition rate in the strength group are problematic. We attempted to correct for this problem by using an ITT analysis. Despite the high attrition rate we were able to show significant strength and selected functionality changes between the 2 groups. High attrition rates with intervention programs are not an unusual finding for this population. Other studies have reported attrition rates anywhere from 7% to 67%[2-4,8,9,14-16,25,29,30,32] with their interventions. We do not believe that the strength training exacerbated the symptoms of the women in our study except for perhaps 1 subject who dropped out due to a flare-up; however, she was having problems prior to and during the pretesting period. Future studies may need to question the commitment of women with fibromyalgia before randomizing them into their treatment groups. Evaluating depression and anxiety as a criteria for inclusion into studies may also be important in controlling for attrition.

Another limitation in our study is that the CS-PFP test has not been validated in the fibromyalgia population. However, the CS-PFP test has been validated by Cress et al[21] in older adults with a broad range of physical abilities. It has been documented that women with fibromyalgia have lower functional capabilities and perform routine tasks of daily living similar to older adults.[5-7] Future research needs to evaluate this test because an objective measurement for physical function in this population is needed. We did find retest reliability to be high with the CS-PFP test in the women with fibromyalgia ($r=.90$). This is important because their pain can vary from day to day. The control group in our study had no significant changes in the measured parameters of functionality. In the ITT analyses the upper-body strength domain of the functionality test did significantly improve in the

strength group compared with the controls. Because the design of the study was to increase strength, it would seem logical that the strength components of the functionality test would improve. When the data of only the subjects who completed the study were analyzed, the upper-body strength domain, lower-body strength domain, and total functionality were improved over the control group. When looking at the raw data of the functionality tests in table 5, the tests that had improvements were the tests that required some component of strength such as carrying weighted bags. Therefore, although the CS-PFP test has not been validated in this population, it does provide evidence that strength increases from exercise training can improve tasks of routine daily living that have strength as a component.

CONCLUSIONS

The 12-week progressive strength-training program not only significantly increased strength but also increased selected components of functionality. This program did not exacerbate fibromyalgia symptoms in the women who completed the study and did not result in musculoskeletal damage or injury. The women improved strength and functionality of routine tasks of daily living with 1 set of 8 to 12 repetitions of 11 exercises that worked the major muscle groups of the body, performed twice a week at an intensity of 60% to 80% of initial 1-RMs.

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Suppliers

a. Nautilus, 1400 NE 136th Ave, Vancouver, WA 98684.
b. Model 700; Seca, 1352 Charwood Rd, Ste E, Hanover, MD 21076.
c. Lunar DPX-IQ; GE Medical, 726 Heartland Trl, Madison, WI 53717.
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