The Effects of a 12-Week Progressive, Full Body, Strength-Training Program in Women with Fibromyalgia

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THE EFFECTS OF A 12-WEEK PROGRESSIVE, FULL BODY, STRENGTH-TRAINING PROGRAM IN WOMEN WITH FIBROMYALGIA

By

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I would like to dedicate this study to Georgia Kingsley, my mother. Without her, this study never would have been able to happen. When she was diagnosed with fibromyalgia in 1999, I had no idea what fibromyalgia was, how to diagnosis it, or treat it, for that matter. Since that time, my knowledge on the subject of fibromyalgia has grown. Not one day passed that I did not think of my mother and the pain she endures on a daily basis. The women I worked with always reminded me of why I was doing the study. My work deserves to be dedicated to the one in my life who has had the most influence. This study is for my mother.
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ABSTRACT

Persons with fibromyalgia (FMS) may have compromised muscular strength and muscular endurance due to their disease. **PURPOSE** The purpose of the present study was to determine whether women with FMS could benefit from a 12-week strength-training program by decreasing tender point sensitivity, fibromyalgia disease impact, and increasing strength and functionality. **METHODS** Twenty women (46.1±7.1 yr) previously diagnosed with FMS participated in the study. Muscular strength was assessed by a maximal one-repetition strength test (1-RM) for upper and lower body. Tender point reactivity and sensitivity was manually assessed by a board certified rheumatologist. Fibromyalgia impact was assessed by the Fibromyalgia Impact Questionnaire (FIQ). Body composition was assessed by Dual Energy X-ray Absorptiometry (DEXA). Functionality was assessed by utilizing the Continuous Scale-Physical Functional Performance Test (Cs-PFP) that consists of tasks that simulate ADL. The Cs-PFP consists of 5 domains, upper body strength, upper body flexibility, lower body strength, balance and coordination, and endurance as well as an overall score of functionality. Subjects were randomly assigned to a control (C: n=12) or strength (S: n=8) group. The 12-week training program consisted of 11 exercises that focused on the major muscle groups of the body. Subjects exercised twice a week performing 1 set of 8-12 repetitions at 40-60% of their 1-RM and progressing to 60-80% of 1-RM. Two-way ANOVA was used to assess significance (p<0.05) between groups for all variables. **RESULTS** The strength-training group showed significant improvements in upper body (C: 39±11 to 38±10kg; S: 41±10 to 44±11kg) and lower body (C:59±18 to 59±20kg; S: 53±19 to 79±24kg) 1-RM measurements compared to the controls. Scores for total functionality measured by the Cs-PFP were significantly improved for the strength (52.6±15.9 to 64.7±14.5 units) vs control (51.3±13.6 to 54.8±15 units) after training. There were no significant changes for tender point reactivity (C: 11±6 to 12±5; S: 12±5 to 9±5), sensitivity (C: 11±6 to 12±5; S: 12±5 to 9±5) fibromyalgia impact (C: 56.2±12.3 to 52.7±13.0 units; S: 54.2±23.2 to 42.6±17.0 units), and body composition of percent fat (C: 38.5±15.7 to 38.9±15.5 %Fat; S: 29.3±10.8 to 30.1±10.7 %Fat). **CONCLUSIONS** The 12-week strength-training program significantly improved strength and functionality in women with FMS. These changes have important implications on independence and quality of life issues in women with FMS.
CHAPTER 1
INTRODUCTION

Fibromyalgia or Fibromyalgia syndrome (FMS) is an idiopathic, rheumatoid syndrome characterized by not only chronic pain, but also a wide array of symptoms (5,16,22,34). These symptoms include: sleep disturbance, chronic fatigue, morning stiffness, irritable bowel syndrome, anxiety, depression, mental fogginess, slowness of thought, decreased concentration, parasthesia and pain upon moderate pressure at various tender points (5,16,22). Fibromyalgia syndrome can also be associated with other diseases and medical complications (1,12,24). The American College of Rheumatology suggests that 10-15% of those individuals with FMS also have other rheumatoid diseases such as rheumatoid arthritis and osteoporosis (2,16,22,34). Each of these conditions will also make diagnosis of FMS more difficult.

The diagnostic procedures for FMS by the American College of Rheumatology were published in 1990 (34). Diagnosis of FMS is three fold (16,24,34,40). One, the person must have pain in all four quadrants of the body. Two, the pain must be chronic and be present for at least 3 months. Three, moderate pressure upon 11 of 18 specific tender points must elicit a pain response. The tender point diagnosis is a relatively subjective procedure. The physician applies a pressure of 4kg in order to elicit a pain response from the patient (34). If too much pressure is applied, the procedure will not be specific enough and if too little pressure is applied, the sensitivity of the test will be too low.

The prevalence of FMS has yet to be determined (16,22). Studies suggest that there are 3 to 6 million people affected in the United States (16,22). However, this number only accounts for those individuals that are already diagnosed. One study suggests that 15-20% of all people seeing a rheumatologist are being treated for FMS (34). The majority of those affected are women (12,13,16,22,40). The prevalence of men with FMS is less. The ratio speculated for women to men is about 9:1 for those diagnosed (40). The age of diagnosis ranges from 20-55 years of age (1,40).

Medications, over-the-counter and by prescription, support groups, and exercise have all been used to help treat this syndrome (1,5,12-16,20,22,24,25,31,34). However to date, none of these therapies are known to be effective in the long-term treatment of FMS (1,12). The ailments associated with FMS are so diverse that there might not be any simple type of treatment for FMS. A combination of these treatments is likely the best approach, but pain and dysfunction may persist.

The benefits of physical activity are both numerous and multifaceted (1,4,5,11-12,29,31,39). Aerobic activity reduces sleep disturbances (5,22,31), increases aerobic endurance (5,20,34), decreases feelings of pain (5,12,16,25,31), increases ability to cope with pain (5,16,20,25,34), and improves circulation in persons with FMS (20,25,34). Cognitively, aerobic exercise also decreases depression (16,24,31,34), decreases anxiety (16,24,31,34), and increases feelings of self-worth in this population (5,16,24,25,34). However, aerobic programs have not been found to be successful in the long-term care and treatment of FMS (1,12,20).

The benefits of strength training in healthy adults are numerous (10,17,23,39). Benefits include increases in muscle mass and strength (4,16,17,30,35,39), increases in muscle endurance
(4,17,22), decreases in muscle fatigue (4,16,17,22,30), increases in resistance to muscle damage (7,25), and decreases in muscle pain (4,16,22). Persons with FMS have the same needs as healthy individuals concerning strength training. However, little research has focused directly on strength training persons with FMS (1,11,13,14,31). Most studies on persons with FMS have used strength training in conjunction with aerobic training programs. Therefore, strength training in these studies was not the primary focus of the research (5,11,16,22). These studies on FMS and strength training have shown changes in activities of daily living (5,16,22), pain (5,11,16), mood (5,12) and suppression of symptoms such as headache and anxiety (11,21). However, whether the improvements were due to aerobic training or strength training or a combination of the treatments is not known. Most of the researchers evaluating strength-training programs in persons with FMS have only used the body weight for resistance or hand weights of only 3-5 lbs (1). It is unknown whether a full body, progressive resistance strength-training program can be tolerated by persons with FMS and whether it can improve muscular strength and endurance, body composition, fatigue, depression, pain, tender point sensitivity and functionality in this population.

Statement of the Problem

The aim of the present study was to determine if a progressive, full body strength-training program of 12 weeks would improve muscular strength and endurance, body composition, pain, tender point sensitivity and functionality in women diagnosed with primary FMS.

Significance of the Study

Persons with fibromyalgia complain of pain, lethargy, and problems with physical activity. Recent research has demonstrated that chronic aerobic activity aids in decreasing the affect of these symptoms in persons with FMS. Chronic aerobic activity has been shown to have multiple, positive physiological effects such as decreases in resting and exercise heart rate, increases in maximal cardiac output, increases in peak VO$_2$ and increases in ventilatory thresholds in persons with FMS. Researchers have shown that in healthy persons, a full body progressive strength-training program can increase muscle mass and strength, increase bone density, and increase muscular endurance. Current research in persons with FMS has focused on aerobic training and/or a non-progressive strength-training program for easing their symptoms. The role of a full body progressive strength-training program has not been fully researched in this population. However, studies that have utilized full body progressive strength-training programs in persons that have rheumatoid arthritis have shown improvements in strength, pain, and fatigue without exacerbating disease activity or joint pain (30,37). If persons with FMS can receive similar benefits from strength training as individuals with arthritis, then perhaps strength training will become a common treatment intervention for FMS.

Research Hypotheses

The research hypotheses will be that participation in a strength-training program will improve physiological and functional measurements. More specifically:

Ha$_1$: There will be increases in muscular strength and endurance in the strength-training group compared to the control group.

Ha$_2$: There will be increases in lean mass for the strength-training group compared to the control group.
Ha₃: There will be no change in bone mineral density or fat mass for the strength-training group compared to the control group.
Ha₄: There will be decreases in the number of active tender point sites as measured by a board-certified rheumatologist in the strength-training group compared to the control group.
Ha₅: There will be decreases in total tender point sensitivity as measured by a board-certified rheumatologist in the strength-training group compared to the control group.
Ha₆: There will be decreases in overall impact of FMS measured by the Fibromyalgia Impact Questionnaire compared to the control group.
Ha₇: There will be increases in activities of daily living (ADL) measured by the Continuous Scale-Physical Functional Performance (Cs-PFP) test for the strength-training group compared to the control group.

Assumptions
For the purpose of this study, the following assumptions were made:
1. The subjects will follow the testing procedures and exercise guidelines set forth by the researcher.
2. The subjects will give their best efforts during testing and during every exercise training session.
3. The subjects in the control group will not change their activities over the 12-week control period.

Limitations
The researcher recognized the following limitations in the study’s design:
1. The subjects in this study will be volunteers. Volunteers may bring with them a set of unique characteristics that present a threat to the internal validity of the results.
2. The subjects in the study will take their medications as needed. Medication will not be withheld during any of the testing or training sessions. This may influence measurements on the various tests.

Delimitations
Twenty-nine women with FMS between the ages of 18-54 years were recruited for the study. Testing included muscular strength and endurance, pain, fibromyalgia impact, the ability to perform ADL and body composition by Dual Energy X-ray Absorptiometry (DEXA). Pain from tender points was subjectively assessed by a board certified rheumatologist for determination of active tender points as well as total tender point sensitivity. Impact assessment using the Fibromyalgia Impact Questionnaire (FIQ) was used to measure the impact that this disease had on the lives of the women in the study. Activities of daily living were assessed using the Continuous Scale-Physical Functional Performance test (Cs-PFP). All above measurements were taken over a two-week period. Women were randomly assigned to one of two groups, either a strength-training group or a control group. After the 12 weeks of strength training using resistance machines or control period, all testing was repeated. All subjects were informed not to change their lifestyles during the duration of the study.
Definition of Terms

**One Repetition Maximum (1-RM)** - The maximum amount of force that can be produced through a full range of motion one time (23).

**Activities of Daily Living (ADL)** - The activities tested for this study included: carrying a weighted pan, pouring water into a cup, putting on shoes, picking up scarves, putting on a jacket, reaching, floor sweeping, doing laundry, bed making, vacuuming, sitting and standing from the floor, opening a fire door, stair climbing, simulating getting on a bus, carrying groceries, and walking for 6 minutes (7).

**Body Composition** - The percent of total fat mass versus total fat free mass (39).

**Chronic Fatigue Syndrome** - A syndrome where fatigue is the primary symptom.

**Concentric Contraction** - Shortening of a muscle through a full range of motion (17).

**Dual Energy X-Ray Absorptiometry (DEXA)** - A noninvasive radiological projection technique. The energy source is an X-ray that has improved the ability to quantify various parameters of body composition. Radiation exposure is minimal, evaluation time is reduced, and precision is improved by this resolution. This body composition instrument differentiates body weight into three chemical compartments: lean soft tissue, fat soft tissue and bone (39).

**Eccentric Contraction** - Lengthening of the muscle through a full range of motion (17).

**Fibromyalgia Syndrome (FMS)** - A chronic disease of unknown etiology associated with pain, sleep disorders, anxiety, depression and neuralgias (31).

**Hypothalamus-Pituitary-Adrenal Axis (HPA)** - The axis of the body that is proposed to respond in order to reduce the effect of external stressors (3).

**Isokinetic** - During contraction, the velocity remains the same as the muscle moves through its range of motion (30).

**Isometric** - During contraction, the muscle does not lengthen, but the muscle produces force (30).

**Osteoporosis** - A degenerative disease in which the bone loses calcium, therefore there is a reduction in bone mass (39).

**Tender Points** (Figure 1) - According to the American College of Rheumatology there are 18 tender points. To be diagnosed with FMS, 11 of these tender points must be present. Tender points include:

- Occiput: Bilateral, at the suboccipital muscle insertions.
- Low cervical: bilateral, at the anterior aspects of the intertransverse spaces at C5-C7.
- Trapezius: bilateral, at the midpoint of the upper border.
- Supraspinatus: bilateral, at origins, above the scapula spine near the medial border.
- Second rib: bilateral, at the second costochondral junctions, just lateral to the junctions on upper surfaces.
- Lateral epicondyle: bilateral, 2 cm distal to the epicondyles.
- Gluteal: bilateral, in upper outer quadrants of buttocks in anterior fold of muscle.
- Greater trochanter: bilateral, posterior to the trochanteric prominence.
- Knee: bilateral, at the medial fat pad proximal to the joint line (24).
Figure 1

Tender Points from the American College of Rheumatology
CHAPTER 2

REVIEW OF LITERATURE

Etiology

Rheumatic disorders and complications comprise a significant percent of all medical visits (5,31,34). Ten to 15% of all doctor’s visits are comprised of rheumatic disorders, such as rheumatoid arthritis (RA), chronic fatigue syndrome (CFS) and fibromyalgia syndrome (FMS) (22,34). The prevalence of FMS has especially been of interest to rheumatologists (5,34,40). The increase in the number of patients diagnosed with FMS has risen almost exponentially (40).

Fibromyalgia is characterized primarily by chronic pain (5,16,26). Other symptoms include sleep disorders, CFS, morning stiffness, irritable bowel syndrome, anxiety, depression, mental fogginess, slowing of thought, decreased concentration, parasthesis and pain upon pressure at various tender points (5,16,26). The prevalence of FMS has been found to be highest in females with a ratio of 9:1, women to men (2,12,40). Women tend to experience more fatigue, more irritable bowel syndrome and more generalized pain (2,40). Research has been unable to explain the gender differences of FMS. Research has only been able to suggest that overall, females are more susceptible to pain and other external stressors (40).

One possible hypothesis for the etiology of FMS is a disruption of the hypothalamus-pituitary-adrenal axis (HPA axis) (3,28,37). The HPA axis is involved in the response of the body to stress (28). Stress facilitates the secretion of corticotrophin releasing (CRH) hormone from the hypothalamus. This hormone stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary, increasing release of cortisol from the adrenal glands. An increase in plasma cortisol will stimulate a breakdown of muscle protein into amino acids. The amino acids generate glucose via gluconeogenesis in the liver, which acts against hypoglycemia, a stress response. Persons with fibromyalgia have been suggested to have a delayed ACTH response to the release of CRH (3,28,37). This suggests a deficit in CRH control (28).

Therefore, the body is unable to respond to stress appropriately resulting in low levels of cortisol following stress (28,37). Healthy controls have been found to have levels of cortisol following an exercise bout around 0.52±0.2 µmol/l versus 0.37±0.1 µmol/l in FMS patients (37). A low level of plasma cortisol following stress has been linked to increases in fatigue and increases in pain perception (3).

Fibromyalgia patients have also been found to have orthostatic intolerance demonstrated by table-tilt testing (3,6). The table-tilt test places a subject supine on a table. Once the subject is strapped onto the table, the table is brought upright. The response of persons with FMS suggests an altered response of the sympathetic nervous system (SNS) and possibly dysautonomia (3,6). Normally, the body will respond to counteract the orthostatic intolerance by activating the SNS. Dysautonomia may aid in explaining other symptoms of FMS including hypotension, headaches, anxiety, sleep disorders, parasthesis, lower resting heart rates during an exercise bout, and lower levels of norepinephrine (NE) and epinephrine (E) during exercise (3,6,37).

Other neuroendocrine abnormalities such have been found in those with FMS (28,37). These abnormalities might be able to explain why persons with FMS have hypersensitivity to pain and high ratings of perceived exertion (26,28). Hypersensitivity to pain and high ratings of exertion might be explained by over-reactivity of CNS neurons to external stressors (26). Over-
reactivity of CNS neurons can cause chronic exaggerations of responses to pain (hyperalgesia), increases in duration of pain following an external stressor, increases in ratings of perceived exertion or increases in a pain response following a normally non-pain stimulus (allodynia), such as touching or rubbing of the skin (26,28).

Sleep disturbances, a common symptom of FMS, have been found in a majority of FMS patients (2,16,24,28). Sleep disturbances are not considered a primary cause of FMS, but have been shown to be associated with flare-up of symptoms (24,28). Stage three or four sleep, also termed delta sleep or rapid eye movement (REM) sleep, is when the body normally repairs itself (28). Persons with fibromyalgia may have problems getting into delta sleep, which might therefore impair the ability of the body to recover properly, thus exacerbating the symptoms of FMS (24,28).

Treatment for persons with FMS has routinely involved pharmacological or conservative methods (1,26,38). The use of drugs for pain suppression, muscle relaxation, sleep, irritable bowel syndrome, anxiety and depression are commonly used (2,16). Conservative methods such as physical therapy and cognitive training have also been used to treat persons with FMS (9,38). However, none of these treatments has completely alleviated the symptoms in those that suffer with FMS (16,38). Another alternative to treatment of FMS has been aerobic exercise. The use of exercise to alleviate symptomology has yielded better results than some of the pharmacological and conservative methods (5,12,15,16,24).

Aerobic Exercise and FMS

Cardiorespiratory fitness has been shown to be lower in persons with FMS then in healthy, age-matched controls (22,26,31). Cardiorespiratory fitness has been measured using submaximal cycle ergometry tests (26,37), submaximal treadmill tests (22,24), and six-minute walk tests (12,16,20,31) in patients with FMS. Research suggests that maximal exercise testing is not the most effective measure of cardiorespiratory fitness in patients with FMS (26). The use of submaximal exercise has shown to have a higher efficacy (16,26) in this population. One problem with most of these protocols is that heart rate is used as a marker of performance. If FMS patients have a dysfunction of the sympathetic nervous system or of the HPA axis then heart rate may not be considered an accurate marker of performance.

Studies have shown that during aerobic activity heart rates have been lower in FMS versus control subjects (27,37). Following a 5-minute warm up, 15 female subjects with FMS and 15 healthy controls were tested on a cycle ergometer. The initial load was set at 40 Watts with an incremental increase to 70, 100, 130, 150, 170, and 190 Watts every three minutes until volitional fatigue (27). No subject completed a workload over 170 Watts. The average VO_2peak of the FMS subjects was 22 ml/kg/min versus 30 ml/kg/min in the healthy control subjects. The maximal heart rate was also lower in FMS subjects (154±9 bpm), while control subjects had heart rates of 164±7 bpm (p=0.013) (27). One of the reasons why the heart rates in persons with FMS were lower may be due to problems with the sympathetic nervous system (27,37). Another reason exercise maximal heart rates and maximal oxygen consumptions are so much lower is that these individuals cannot generate the energy to exercise at high levels (37). It has also been found that ratings of perceived exertion are much higher at any given exercise intensity compared to age matched controls (37). With the addition of an aerobic exercise program, improvements in oxygen capacity have been seen in persons with FMS (12,15,25,38). Performing aerobic activity at 60-70% of heart rate reserve may cause an increase of 42-56% in
oxygen consumption, similar to that of healthy controls (25). Increases in VO\(_2\) peak, have been associated with decreases in fatigue (15,25,38), decreases in anxiety (12), and improvements in ADL such as the chair-stand test, chair sit-and-reach test, back-scratch test and the 8-feet get-up-and-go test (16).

**Strength Training and FMS**

The majority of research performed on persons with FMS has been on improving cardiorespiratory fitness levels. The idea of using strength training to aid in alleviating symptomology is a recent intervention protocol. Strength training was overlooked as an initial treatment for FMS because it was thought that FMS was a direct cause of muscle trauma (5). Current research has shown that this is not the case. The etiology of FMS may not be muscular, but rather central in nature, so strength training might be beneficial (28,38).

Fatigue is one of the primary symptoms of FMS (2,11,24,27). Fatigue is noted at rest, during and after exercise, and days following an exercise bout (9,16,27). The inorganic Phosphate/Phosphocreatine (Pi/PCr) pathway corresponds to muscle metabolism. The Pi/PCr pathway is utilized during the initial few seconds of physical activity. Rapid depletion of Pi/PCr may correlate with poor muscle metabolism at maximal exertion. The Pi/PCr pathway has been suggested to be altered in persons with FMS (11). Geel (11), utilizing subjects 48±8.3 years, demonstrated no difference in the Pi/PCr pathway at rest for either FMS or control subjects (0.3±0.1 vs. 0.3±0.1 units), respectively. Pre-testing required subjects to perform wrist flexion and extension at 11 contractions per minute. It was found that the Pi/PCr was significantly lower (p<0.05) following this exercise bout in FMS subjects 1.2±0.2, versus 1.6±0.2 units in control subjects. Geel then trained the subjects for 8 weeks at 60% of the patients’ 1-RM. Subjects performed 3 sets of 10 repetitions with one-minute rest periods. Exercises included leg press, shoulder press, latissimus dorsi pull down, bicep curl and military press. All exercises were performed with wall pulley weights. After the 8-week strength training period the responsiveness of the FMS group decreased to 0.6±0.2 units, compared to the control subjects who did not train. This study demonstrated that a strength-training program could normalize and reduce the amount of fatigue associated with an exercise bout in persons with FMS (11).

Muscle pain is the most predominant symptom in persons with FMS (5,16,27,37). Research has investigated the constituents of the blood in order to determine if muscle trauma is present. Increases in myoglobin and creatine kinase have been associated with muscle damage and pain (27,37). Studies have investigated the amount of myoglobin and creatine kinase (CK) in the plasma, both before and after exercise (27,37). Neither study found significant differences in either myoglobin (FMS: 24.7±5 vs. Control: 29.3±6 µg; p>0.05) (37) or of creatine kinase (FMS: 57.5±12 vs. Control: 66.5±21 U/l; p>0.05) (27) between persons with FMS or controls. These data suggest that even though muscle pain is present, it may not be due to muscle damage.

It appears that muscle damage may not be the direct cause of pain in those with FMS (27,37). However, studies using strength training have found that delayed onset of muscle soreness (DOMS) is exacerbated in persons with FMS (5,13,16). Delayed onset of muscle soreness is an acute muscle training effect of predominantly eccentric work (5,10). It has been hypothesized that eccentric work is more effective than concentric work at increasing strength gains (10). It has been suggested that the key in strength training persons with FMS is to reduce the amount of eccentric work (1). Pauses at the end of each movement may also aid in eliminating some of the DOMS experienced in women with FMS (1,16).
In a healthy population strength training is recommended to increase muscle mass and strength, increase muscle endurance, decrease muscle fatigue, increase resistance to muscle damage, and decrease muscle pain (10,17,23,35,39). The American College of Sports Medicine (ACSM) recently published a position statement on strength training. The ACSM set forth recommendations for progression of weight, frequency of training, number of sets, number of repetitions, and the time of rest between sets for healthy adults (17). They recommend that for those individuals beginning a resistance program perform 1-2 sets of 8-12 repetitions, 2-3 days a week (17).

Strength training can also have multiple benefits in other populations such as patients with chronic low back pain (4,21,30), rheumatoid arthritis (29,36) and osteoporosis (39). The use of strength training to increase isokinetic and isometric strength of the low back muscles demonstrated improvements of 19-22% (p<0.05) (30). Carpenter (4) indicated that improvements could occur even with 1 set of 8-15 repetitions.

Strength training for the treatment of rheumatoid arthritis (RA) has also been recommended (29,36). Research suggests that a full-body progressive resistance program may aid in reducing the severity of the disease (29,36). Pain and fatigue are two components of RA. The addition of a strength-training program in patients with RA (41.8±12.6 years) found self-reported reductions in over all pain, as well as joint pain and fatigue (29). The strength-training program in this study consisted of 3 sets of 8 repetitions with a 2-minute rest period between sets. Training occurred twice a week and each session was separated by 2-3 days of rest. Resistance was set at 80% of the 1-RM. The exercises utilized were chest press, leg press, leg extension, back extension, and abdominal crunches. All exercises were performed on pneumatic resistance machines. Following 12 weeks of strength training a 57% (p<0.0005) increase in strength was seen in the RA group. In another study, Van de Ende (36) implemented a progressive strength training protocol for 30 days following hospitalization for complications of RA. The subjects performed strength-training exercises 5 days a week for the entire month. The training protocol utilized isometric and isokinetic machines to strengthen the knee extensors and flexors. The isometric contractions consisted of 3 sets of 5 contractions at 70% maximal voluntary contraction (MVC) during 6 seconds with the knee joint set at 45°. The isokinetic protocol utilized 3 sets of 8 contractions at 70% MVC at 60°/s. The subjects showed significant improvements in strength over a 30-day training period (36). These studies suggest that the addition of a short-term or long-term strength training protocol can decrease the severity of symptoms and increase strength and activity levels in persons with RA (29,36).

The problem with the studies on progressive strength training and FMS is that the protocols have not been similar. Studies have used body weight exercises (11,31), surgical tubing (22), weight machines (11,22,31) and 3-5lb hand weights (31). Not only has the type of weight been different with each study, but also the intensity and frequency of training. Frequency has ranged from 3 times a week for 20 minutes (22), 3 times a week for 60 minutes (31), and two times a week for 30 minutes (11). Intensity has been based on 1-RM for some studies (11,31) or on voluntary weight selection for others (22).

Research concentrating on strength training for persons with FMS has been very limited (11,31). However, the few studies that have been completed on persons with FMS have yielded positive results. One strength-training program that lasted 8 weeks showed a 43-53% (p<0.05) increase in maximal strength in persons aged 48±8.3 years with FMS (11). Selected exercises included leg press, shoulder press, latissimus dorsi pull down, bicep curl and military press (11).
Subjects performed exercises twice a week at 60% of 1-RM. Three sets were performed with 10 repetitions per set with one-minute rest periods. All exercises were performed with wall pulley weights (11). The researcher also found decreases in sleep disturbances by 49% (p<0.005), decreases in psychological stress by 52% (p<0.01), and decreases in the FIQ by 47% (p<0.0005). Pain threshold was measured by an algometer at 8 bilateral tender points. Algometer scores were 15.6 ± 2.9 prior to training and 21.2 ± 6.4 (p<0.05) following the strength-training protocol (11). The higher score indicates an increase in the threshold of pain following training.

In another study, Rooks (31) utilized 10 exercises that included hip flexion/extension, knee extension/flexion, ankle plantar/dorsiflexion, shoulder flexion, extension, abduction, and horizontal adduction and abduction, elbow flexion and extension, and trunk flexion and rotation. The strength-training program consisted of 4 sets with repetitions pyramiding 8-10-12-12. Flexibility was also assessed. Following the 16 weeks of strength training the chest press 1-RM increased from 61±18 lbs to 76±18 lbs, an increase of 26.4%, (p<0.001) and the leg press 1-RM increased from 191±75 lbs to 265±67 lbs, an increase of 38.7% (p<0.0002).

Martin (22) measured the isokinetic strength of persons with FMS using a Cybex dynamometer. Martin measured the flexion and extension of the knee and external and internal rotation of the shoulder. Power was measured at three speeds 90°/s, 180°/s and 240°/s. The training protocol, which was 6 weeks, consisted of 5 exercises utilizing the bench press, hamstring curl, leg press, latissimus dorsi pull down, and abdominal curls. All exercises were performed on a Universal Gym (22). After the 6-week training period, the tests were repeated, and no significant difference in either strength or power was seen. The researcher pointed out that 6-weeks of strength training was probably not enough to elicit a change in persons with FMS. However, since they were tested on isokinetic machines and trained on a universal system perhaps the isokinetic machine could not pick up the gains in isotonic strength.

Psychological Factors of FMS

Research has also focused on the psychological aspects of FMS (12,16,20,22,24,25). Questionnaires have inquired about state and trait anxiety (12,24,25), depression (12,16,24,25), and self-efficacy (20,22,25) of persons diagnosed with FMS. It has been found that persons with FMS have more anxiety, more depression and lower self-efficacy than healthy adults (14,16,25).

One questionnaire that has been widely used is the Fibromyalgia Impact Questionnaire (FIQ) (20,22,24,31). The FIQ is a twenty-question questionnaire that addresses such issues as quality of life, ability to perform ADL, pain during activities, morning stiffness, and sleep. The FIQ allows for measurement of changes in overall symptom severity and functional status. This test has been used to test these characteristics prior to and after an intervention, in order to determine its efficacy (24). The test involves adding up points awarded to all questions, the higher the score the greater the affect of the disease. Baseline for the FIQ prior to any intervention was 44.3±9 units (24,31). Following an exercise intervention of strength training and aerobic exercise the score on the FIQ was decreased by 12.5±13.7 units (p<0.01) with a new score of 31.8±13.5 units (p<0.002) (31). This is a 36.8% decrease in impact of the syndrome. Thus, these results demonstrate an improvement of perceived functional status and a decrease in symptoms following an exercise protocol.
Summary

In summary, persons with FMS experience a wide array of symptoms including sleep disturbance, chronic fatigue, morning stiffness, irritable bowel syndrome, anxiety, depression, mental fogginess, slowness of thought, decreased concentration, parasthesia and pain upon moderate pressure at various tender points. Treatment options have included pharmacological interventions and conservative interventions such as physical therapy and exercise. Much of the research involving exercise has focused on primarily aerobic activity. Persons with fibromyalgia have been shown to have poor muscle metabolism, lower muscular endurance and lower oxygen consumption. Aerobic exercise may aid in improving muscle metabolism, muscular endurance and oxygen consumption. Studies have shown that aerobic exercise aids in decreasing some of the symptoms of FMS including decreases in sleep disturbances, decreases feeling of pain, increases ability to cope with pain, and improves circulation. The problem with this type of training is that it does not provide assistance with other problems associated with FMS. Such problems include muscle atrophy and weakness, loss of bone density, and decreased performance of ADL. These problems, which are common to FMS, may be improved with the addition of a strength-training program.

It has been demonstrated that significant improvements have been made when using a strength-training program in patients with RA. Research has consistently shown that a full-body progressive strength-training program of varying intensities (65-80%) can produce significant strength gains in patients with RA. It, therefore, can be suggested that a strength-training program may be of benefit to other populations such as FMS patients.

Research has not been conclusive on the benefits of strength-training exercise on the treatment for FMS. Some studies have shown improvements in strength, fatigue, selected activities of daily living, pain, mood and suppression of symptoms such as headache and anxiety. Other studies have found no improvement in strength and power. A generalized strength training prescription has not been recommended by the American College of Rheumatology. The lack of consistency in results may be to study design differences in which researchers used varying amounts of intensity, duration and frequency in strength training protocols. Thus, although there is some evidence for positive effects of strength training for persons with FMS, further study is needed to develop consensus as well as determine the optimal exercise training protocol. Therefore, the purpose of the present study is to determine if a progressive, full body strength-training program of 12 weeks will improve muscular strength and endurance, body composition, fibromyalgia impact, tender point sensitivity and functionality in women diagnosed with primary FMS.
CHAPTER 3
RESEARCH METHODOLOGY

The purpose of this study was to determine if a progressive full body strength-training program might benefit those diagnosed with FMS. A progressive strength-training regime has yet to be quantified as a treatment of FMS. The data obtained from this study might be able to provide a bit of insight into the benefits of a progressive full body strength-training program for persons with FMS.

This chapter provides specific information related to the research methodologies used to conduct the study; (a) the subjects, (b) the specific exercise protocols that were used, and (c) the statistical analysis methodologies of the study. This information will provide an understanding of the methods and protocols for this study’s specific FMS subject population.

Subjects
The subjects for this study were recruited from an advertisement placed in the Healthbeat section of the local newspaper, The Tallahassee Democrat. Of the 122 calls, twenty-nine female volunteers were selected to participate in the study. The age of the subjects was between 18-54 years. All subjects had been clinically diagnosed with primary FMS. Subjects were excluded from the study 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 FSU IRB committee and documented informed consents were obtained from all subjects prior to testing (Appendices A and B, respectively). Upon completion of pretesting subjects were randomly assigned to one of 2 groups, a strength training or a control group. Subjects picked from a bag, a golf ball either white or orange in color. The orange ball was the strength-training group and the white ball was the control group. The subjects in the strength-training group participated in a progressive full body strength-training regime twice a week. The strength-training group performed activities using resistance machines. The subjects in the control group were asked not to change their activity levels during the 12-week intervention period.

Research Protocol
All subjects were required to participate in 7 days of pretesting, which included the measurements of muscular strength and muscular endurance, body composition measures (DEXA), tender point reactivity and sensitivity, FMS impact, and ADL. Following the pretesting period, the strength-training group participated in a 12-week progressive full body strength-training program. The subjects in the control group were asked not to alter their activity levels for the 12 weeks. At the end of the 12-week training period or control period, all subjects repeated the same tests that they completed at the beginning of the study. These posttests were then compared with the pretests to determine the physiological and psychological effects of a strength program on patients with FMS.
On the first visit, subjects were oriented to the study and completed the informed consent and questionnaires. Day two consisted of blood pressure, height and weight measurements, and the BIODEX strength measures. On the third visit, blood pressure and body composition were measured via a DEXA scan. On the fourth visit, ADL were measured using the Continuous Scale-Physical Function Performance (Cs-PFP) test. On the fifth visit, subjects were evaluated by a board-certified rheumatologist for the number of active tender points and total tender point sensitivity and filled out the FIQ. On the sixth and seventh visits, subjects performed 1-RM testing.

**Strength Testing**

Measurements for maximal strength were performed on the Nautilus™ Chest Press for upper body strength and the Nautilus™ Leg Extension for lower body strength (Appendix C). Strength measures were completed at Communicare Wellness Center, owned and operated by Tallahassee Orthopedic Sports and Physical Therapy (TOSPT). Subjects were given a warm-up of 8-10 repetitions before testing began. Once the warm-up was complete, subjects were then progressed towards a maximal weight that they could move only one time with the upper body and the lower body through a complete range of motion (1-RM). Following a minimum of 72 hours of rest, the subjects returned and the upper and lower body 1-RMs were verified. Encouragement of the subjects was standard. The highest measurement for the upper and lower body from the 2 days of testing was considered the 1-RM.

Measurements of maximal force production and fatigue were performed on a BIODEX™ System 3 Isokinetic Strength System (Shirley, NY). The dominant leg was measured for peak force and endurance. Peak force production was measured at 60°/s, 120°/s, and 180°/s. A one-minute rest period was given between trials. The BIODEX™ allows for concentric/concentric movement, thus eliminating any eccentric movement. Isometric peak force production was measured at an angle of 60°. A fatigue test utilizing 180°/s for 50 repetitions was also measured. From the fatigue test, a fatigue index was extrapolated from the three highest peak contractions and the three lowest peak contractions.

Handgrip strength was assessed using a Jamar™ (Lafayette, Indiana) handgrip dynamometer to determine maximal grip strength. Subjects performed 3, 1-handed squeezes for each hand. The maximal score for each hand was recorded, then totaled (Appendix D).

**Body Composition**

Bone density was evaluated by the Lunar™ DPX-IQ (Madison, WI) noninvasive dual-energy X-ray absorptiometry (DEXA) to determine whole body and subregional densities. The DEXA was also used to measure fat free and fat masses. Dual energy X-ray absorptiometry was conducted in the Exercise Physiology Laboratory on the first floor of the Sandels Building on the campus of The Florida State University. Dr. Reed Mathis conducted all of the scans.

**Tender Point Reactivity and Sensitivity**

Tender point reactivity and sensitivity was assessed by a board certified rheumatologist, Dr. Victor McMillan of the McIntosh Clinic in Thomasville, GA. The reactivity and sensitivity was based on the sole judgment of the rheumatologist. The rheumatologist tested all eighteen of the tender points for sensitivity (Figure 1). The rheumatologist then rated the sensitivity of the
pain on a scale of 0 (no pain) to 3 withdrawal of the patient from the examiner). The
rheumatologist was blind as to which group the subject was participating (Appendix E).

The Fibromyalgia Impact Questionnaire

The Fibromyalgia Impact Questionnaire (FIQ) was used to assess the impact of FMS on
persons diagnosed with the syndrome. It consists of 20 questions on a continuum. It asks
questions pertaining to the ability to perform ADL, sleep disturbances, mood, and day-to-day
pain (Appendix F).

Continuous Scale-Physical Functional Performance (Cs-PFP) Test

Subjects were also tested on their ability to perform 17 tasks that simulate routine, daily
activities of living (Appendix G). Blood pressure was taken prior to testing. Heart rate and
ratings of perceived exertion (RPE) were recorded before and after each task, as well as at the
end of the entire test. Polar heart rate monitors were used to record heart rate. Transfer belts
were worn by the subjects in order to prevent falls. Time to complete a task was the
performance marker for 15 of the 17 tests that consist of: carrying a weighted pan, pouring water
into a cup, putting on a Velcro strap around a shoe, picking up scarves from the floor, putting on
and taking off a jacket, sweeping kitty litter off the floor, doing laundry, making a bed,
vacuuming oatmeal off the carpet, sitting and standing from the floor, opening a fire door,
climbing 12 steps, climbing on a simulated bus with a weighted bag, carrying groceries 40
meters and walking for 6-minutes. The only test that was not timed was a reaching test. In this
test, a sponge was placed upon and removed from a shelf above the subject’s head. The testing
was performed in a temperature-controlled environment with standard encouragement.

Strength Training

The subjects in the strength-training group were required to attend the exercise program.
The subjects trained twice a week for 12 weeks. Training occurred at Communicare Wellness
Center at Tallahassee Community Hospital owned and operated by TOSPT in the Tallahassee
area. The strength-training sessions were performed on Nautilus™ resistance machines and
included biceps low pulley curl, triceps extension, standing row, chest press, leg extension,
stANDING leg curl, standing calf raises, body weight squats, shoulder press, lumbar extension and
abdominal crunches. Subjects performed 5 minutes of warm up and cool down before and after
strength training. Following completion of all exercises, ratings of perceived exertion were
obtained and recorded. Subjects received an upper body stretch for the arms and chest following
each training session. Subjects began training at 40% of their 1-RM. Once 12 repetitions were
performed with proper form and without struggling, the weight was increased by 5-10 pounds.
The 1-RM was evaluated every 4 weeks. The duration of each session was approximately 30
minutes.

Statistical Analysis

The design of this study was a two-group pretest-posttest experimental design. The study
contained two testing periods, one occurred prior to and the other after the 12-week program.
One-way analysis of variance (ANOVA) statistical analyses was completed in order to account
differences between groups on the last factor. Dependent variables for the pretest and posttest
were analyzed by a Two-way (groups x pre/posttest) ANOVA with repeated measures. All significance was accepted at p<0.05.
CHAPTER 4
RESULTS AND DISCUSSION

The present study was completed over an 18-week period of time that consisted of 2 weeks of testing before and after the 12-week strength-training period. The purpose of the study was to determine if a progressive, full body strength-training program of 12 weeks would improve muscular strength and endurance, body composition, fatigue, pain, tender point sensitivity, fibromyalgia impact, and functionality in women diagnosed with primary FMS.

To explore the purpose, seven hypotheses were developed. The hypotheses proposed were: 1) there would be increases in muscular strength and muscular endurance in the strength-training group compared to the control group, 2) there would be increases in lean mass for the strength-training group compared to the control group, 3) there would be no changes in bone mineral density or fat mass for the strength-training group compared to the control group, 4) there would be decreases in the number of active tender point sites as measured by a board-certified rheumatologist in the strength-training group compared to the control group, 5) there would be decreases in the total tender point sensitivity as measured by a board-certified rheumatologist in the strength-training group compared to the control group, 6) there would be decreases in the overall impact of FMS measured by the Fibromyalgia Impact Questionnaire (FIQ) compared to the control group, and 7) there would be increases in the performance of the activities of daily living (ADL) tests for the strength-training group compared to the control group.

Subjects

Of the 122 telephone calls of interested women wanting to participate in the study 29 female subjects were tested. The subjects were randomized into either a control (n=14) or a strength training (n=15) group. Randomization occurred by having subjects pick a colored ball out of a paper bag. If the colored ball was chosen, the subject was assigned to the strength-training group. If the white ball was chosen, the subject was placed into the control group. Of the 29 subjects, 20 subjects completed the study, 12 in the control group and 8 in the strength-training group. One control subject underwent surgery for her parathyroid gland and one control subject did not return phone calls for post-testing. Seven subjects did not complete the strength-training protocol. One of these subjects was diagnosed with reflex sympathetic disorder (RSD) in her foot and wrist, another subject stopped showing up for training sessions after the second week, three of the strength-training subjects had flare-ups that lasted for over a month, one subject had surgery for polyps and was unable to complete the study, and one subject had such an anxiety disorder that strength training was virtually impossible for her to do. Subject characteristics for the 20 subjects are presented in Table 1. The two groups were similar (p>0.05) with respect to age, height, weight, disease duration, BMI, and percent body fat.
Table 1. SUBJECT CHARACTERISTICS (N=20).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL (n=12)</th>
<th>STRENGTH (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>47.6 ± 4.0</td>
<td>44.0 ± 11.5</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.63 ± .06</td>
<td>1.63 ± .05</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>86.8 ± 23.1</td>
<td>72.8 ± 13.8</td>
</tr>
<tr>
<td>FMS Duration (yrs)</td>
<td>7.2 ± 4.5</td>
<td>6.0 ± 7.1</td>
</tr>
<tr>
<td>BMI (kg/m^2)</td>
<td>32.3 ± 7.2</td>
<td>28.0 ± 5.9</td>
</tr>
<tr>
<td>% Fat^1</td>
<td>45.5 ± 8.5</td>
<td>41.3 ± 7.4</td>
</tr>
</tbody>
</table>

Values are means ± SD.

^1Determined from DEXA.

Strength Measurements

One component of a strength-training program is training intensity. The intensity of this particular strength-training program was low. This intensity range was appropriate because most of the individuals were deconditioned and were extremely sore on a day-to-day basis. Low intensity training was a key contributor to the fact that no one was injured during the three months of training and for the few flare-ups that occurred. Both upper and lower body strength measurements were obtained from appropriate 1-RM measures and were taken at the beginning, at 4 weeks, at 8 weeks, and at the end of the study. The initial training percentages for upper and lower body, expressed as a percentage of the initial 1-RM, was approximately 40% and 30%, for the upper and lower body respectively, at the beginning of the study. The intensity was slowly progressed to 80% for the upper and 60% for the lower body expressed as a percentage of the week eight 1-RM by the end of the 12 weeks. Table 2 presents the measurements for 1-RM values for upper and lower body for pre, week four, and week eight and the corresponding training intensities.

Table 2. 1-RM VALUES AND TRAINING INTENSITY AS A PERCENTAGE OF 1-RM FOR UPPER AND LOWER BODY FOR WEEKS FOUR, EIGHT, AND TWELVE (N=8).

<table>
<thead>
<tr>
<th></th>
<th>UPPER BODY</th>
<th>LOWER BODY</th>
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<tbody>
<tr>
<td>1-RM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRE</td>
<td>43.0 kg</td>
<td>47.0 kg</td>
</tr>
<tr>
<td>WEEK 4</td>
<td>45.0 kg</td>
<td>50.0 kg</td>
</tr>
<tr>
<td>WEEK 8</td>
<td>45.0 kg</td>
<td>59.0 kg</td>
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<table>
<thead>
<tr>
<th>INTENSITY</th>
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<tbody>
<tr>
<td>WEEK 4</td>
<td>40%</td>
</tr>
<tr>
<td>WEEK 8</td>
<td>60%</td>
</tr>
<tr>
<td>WEEK 12</td>
<td>80%</td>
</tr>
</tbody>
</table>

^1-RM=One repetition maximum
Training intensity for the upper body increased by 20% every four weeks. This was due to the 1-RM for the upper body changing just slightly through the course of the study, while the weight used for training increased by 5 lbs. every three training days. The 1-RM for the lower body increased steadily. The training intensity for the lower body increased by 15% every four weeks.

For the present study, subjects started at 8 repetitions and progressed to 12 repetitions on separate training days. Once 12 repetitions were completed comfortably, the weight was increased by 5 lbs. for upper body and 10 lbs for lower body exercises. Subjects moved from one exercise immediately to the next, without a rest period. The sequence of exercises was the same every session. Each session lasted 30 minutes.

Strength testing was comprised of two types of testing measurements 1) the 1-RM testing using the nautilus machines and 2) isokinetic testing using the BIODEX™. The Nautilus™ Chest Press and Nautilus™ Leg Extension were utilized to measure 1-RM. All strength measurements are presented as 1-RM in Table 3. One subject in the strength-training group had rotator cuff surgery at the end of the study and did not perform the Chest Press 1-RM. The upper body strength increased in the strength-training group 6.8%, pre to post, which was significantly different from the control group (F(1,17) =5.455, \( p \leq 0.05 \)). Lower body strength was also significant from the control group (F(1,18) =40.058, \( p \leq 0.05 \)). Lower body strength increased in the strength-training group by 32.9%, pre to post. Handgrip grip strength did not increase for the strength group over the 12 week. A larger increase in strength was seen in the lower body as compared to the upper body. This may have been due to the way the chest press was built. The subjects had a difficult time getting the weight to move at the start of the lift during the 1-RM testing. The handles were placed at an awkward position for the women. A lack of isometric force in the upper body may have contributed to this small increase. Another reason for the small increase in strength may be due to their disease and that most of the pain associated with FMS is localized in the upper body especially at the base of the neck, and upper arms. Therefore, it makes exercising this area extremely difficult.

<table>
<thead>
<tr>
<th>Strength Exercise</th>
<th>CONTROL (n=12)</th>
<th>STRENGTH (n=7)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>CP (kg)</td>
<td>39 ± 11</td>
<td>38 ± 10</td>
</tr>
<tr>
<td>LE (kg)</td>
<td>59 ± 18</td>
<td>59 ± 20</td>
</tr>
<tr>
<td>Grip (kg)</td>
<td>38.3 ± 11.8</td>
<td>36.3 ± 11.6</td>
</tr>
</tbody>
</table>

Values are means ± SD
Values presented in kg.
*\( p \leq 0.05 \) significantly different from control group after 12 weeks of strength training.
A study similar to the present study was completed by Geel. Geel (11) had subjects, average age 48±8.3 years, perform 60% of their 1-RM, twice a week, for 8 weeks. They performed 3 sets of 10 repetitions, whereas the present study utilized 1 set for 8-12 repetitions. Geel’s study demonstrated a 43-53% (p<0.05) increase in maximal strength using wall-pulley weights. Geel reported that 2 subjects withdrew from the study due to orthopedic complications and illness. The present study although longer in duration, and at a slightly lower training intensity and volume, showed similar strength gains in lower body strength as the study by Geel.

In another study, Rooks (31) utilized 10 various exercises with 4 sets, and repetitions pyramiding 8-10-12-12 using subjects with an average age of 45±9 years. Rooks’ study lasted 16 weeks and demonstrated significant increases in chest press 1-RM (p<0.001) and leg press (p<0.0002) of 26.4% and 38.7%, respectively. Rooks’ study had subjects performing isolation exercises that included shoulder abduction/adduction, hip flexion and extension. The present study also had similar gains in lower body strength as compared with Rooks. Rooks also had a similar drop out rate with 30 subjects beginning the study and only 15 subjects completing the training protocol. Non-FMS-related illnesses were reported as the reason for the high dropout rate in the study by Rooks. No injuries were reported from the training program during the course of the present study. The low strength gains in the present study for upper body measurements were likely due to the problems the women had with the chest press machine and not being able to initiate the movement of the machine in the flexed position without help.

Strength measurements obtained from the Biodex™ are presented in Table 4. The dominant leg was measured for peak force and endurance. Isokinetic peak force production was measured at 60°/s, 120°/s, and 180°/s. A one-minute rest period was given between trials. Isometric peak force production was measured at an angle of 60°. A fatigue test utilizing 180°/s for 50 repetitions was also measured. From the fatigue test, a fatigue index was extrapolated from the three highest peak contractions and the three lowest peak contractions.

The only measurement from the Biodex™ that was significant between groups was 180°/s hamstring flexion which increased by 16.3% (F(1,18) = 5.311, p≤0.05), in the strength-training group compared to the control. This is not unusual since the mode of training was different from the testing device. In addition, the hamstrings tend to be a neglected muscle group compared to the quadriceps. The standing hamstring curl was performed during the 12 weeks of strength training. It may be that isolating the hamstrings allowed for an increase in peak force production.

Although there was only one interaction effect with the Two-way ANOVA, a One-way ANOVA did demonstrate a significant increase of 24.0% (F(1,7) = 11.567, p≤0.05) at 120°/s isokinetic quadriceps extension for the strength-training group. There was also an increase of 16.9% (F(1,7) = 8.380, p≤0.05) at 60° isometric quadriceps extension and an 11.6% increase (F(1,7) = 8.0818, p≤0.05) at 60° isometric hamstring flexion in the strength-training group, pre to post. There were no pre to post differences when using a One-way ANOVA for the dependent measures of strength in the control group.
Table 4. BIODEX™ PEAK TORQUE STRENGTH MEASUREMENTS BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=20).

<table>
<thead>
<tr>
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<th>CONTROL (n=12)</th>
<th>STRENGTH (n=8)</th>
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<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>60°/s Quad.</td>
<td>105.8 ± 40.6</td>
<td>107.5 ± 33.2</td>
</tr>
<tr>
<td>60°/s Ham.</td>
<td>52.1 ± 26.7</td>
<td>48.5 ± 14.8</td>
</tr>
<tr>
<td>120°/s Quad.</td>
<td>82.7 ± 27.8</td>
<td>93.6 ± 28.8</td>
</tr>
<tr>
<td>120°/s Ham.</td>
<td>45.5 ± 21.8</td>
<td>44.7 ± 15.9</td>
</tr>
<tr>
<td>180°/s Quad.</td>
<td>73.8 ± 23.7</td>
<td>79.4 ± 23.1</td>
</tr>
<tr>
<td>180°/s Ham.</td>
<td>41.9 ± 16.6</td>
<td>37.5 ± 10.9</td>
</tr>
<tr>
<td>60° Isom. Quad.</td>
<td>101 ± 33.8</td>
<td>110.4 ± 41.4</td>
</tr>
<tr>
<td>60° Isom. Ham.</td>
<td>63.1 ± 17.3</td>
<td>64.6 ± 16.4</td>
</tr>
<tr>
<td>Fatigue Index (%)</td>
<td>46.1 ± 14.1</td>
<td>53.1 ± 13.1</td>
</tr>
</tbody>
</table>

Values are means ± SD.  
Strength measures are measured in Nm.  
† p≤0.05 significantly different from pre test after 12 weeks of strength training.  
* p≤0.05 significantly different from control group after 12 weeks of strength training.  
Isom.= Isometric; Quad. = Quadriceps; Ham. = Hamstrings

Martin (22) utilized a Cybex dynamometer to test isokinetic knee flexion and extension at 90°/s, 180°/s, and 240°/s. Subjects, average age 44±10 years, strength trained for 6 weeks using a Universal Gym. Training exercises included bench press, hamstring curl, leg press, latissimus dorsi pulldown, and abdominal curls. No significant changes were seen during post testing at any of the speeds. The researcher noted that six weeks might not be enough time to elicit changes in maximal strength. Findings from the present study support the results demonstrated by Martin (22). This was probably due to the fact that the testing was completed on a different type of exercise machine than the training.

Hakkinen (14) utilized a dynamometer to test unilateral isometric force of the knee flexors and extensors at 110° and 107° using subjects with an average age of 38±5 years. Following 21-weeks of strength-training utilizing 5 sets of 10 repetitions for leg extension and leg press, testing was repeated. Other exercises included bench press, triceps pushdown, lateral pulldown, biceps curl and leg adduction/abduction. Training was performed twice a week at 70-80% 1-RM. The present study also used a total body strength-training program involving 11 exercises that were performed twice a week. The intensity of this study was at low to moderate intensity similar to the other studies although the number of sets and repetitions were lower. Measurements of 1-RM were made every four weeks throughout the study. There was a personal trainer working with each participant at every training session. Even though fewer sets were used for this study as compared to others, strength gains were still achieved. The components of this training protocol were shown to be beneficial for persons with FMS who may fatigue quickly and who may find it difficult to exercise at higher intensities and frequencies (24).
Body Composition

With improvements in strength, researchers may or may not find improvements in body composition. One reason differences may not be found is due to the techniques that are utilized. This study used DEXA to evaluate lean mass, fat mass, bone mineral density and percent body fat. Table 5 presents the measurements obtained from the DEXA body composition and bone mineral density analyses. One subject in the control group was unable to attend the DEXA scan due to scheduling conflicts. There were no differences in body weight, total lean mass, fat mass or percent body fat between the two groups. Since this study utilized low to moderate intensity training, twice a week, it may not have been a strong enough stimulus to produce changes in lean muscle mass, fat mass, and bone mineral density.

Table 5. BODY COMPOSITION MEASUREMENTS¹ BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=19).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL (n=11)</th>
<th>STRENGTH (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Body Weight (kg)</td>
<td>86.8 ± 23.1</td>
<td>87.9 ± 23.1</td>
</tr>
<tr>
<td>Lean Mass¹ (kg)</td>
<td>43.3 ± 7.18</td>
<td>43.8 ± 7.18</td>
</tr>
<tr>
<td>Fat Mass¹ (kg)</td>
<td>38.5 ± 15.7</td>
<td>38.9 ± 15.5</td>
</tr>
<tr>
<td>BMD¹ (g/cm²)</td>
<td>1.22 ± .009</td>
<td>1.21 ± .009</td>
</tr>
<tr>
<td>Body Fat¹ (%)</td>
<td>43.9 ± 8.4</td>
<td>44.0 ± 8.4</td>
</tr>
</tbody>
</table>

Values are means ± SD.
BMD=Bone Mineral Density
¹Derived from DEXA

Even though there were no significant increases in lean muscle mass, both the 1-RM for upper and lower body still increased. A reason for the lack of change in lean body mass may be due to the low to moderate training intensity which might not have been enough to elicit changes in lean muscle mass (33). However, this intensity might be enough to elicit neurological and/or hormonal changes (14,33). Neurological and/or hormonal changes might then explain an increase in maximal strength without compensated changes in lean muscle mass. Research supports that the etiology of FMS may be neurological derangement (3,6). This neural derangement may require additional time for physiological adjustments to occur (14). Women have been shown to have lower levels of anabolic hormones and women with FMS have been shown to have lower levels of growth hormone, which may have limited their ability to increase lean mass (33). There have been no other studies that have evaluated body composition changes in women with FMS that underwent a strength-training program.

Tender Point Reactivity and Sensitivity

The score for the total tender point reactivity and sensitivity was based on the subjective measure of the board-certified rheumatologist. Table 6 presents the measurements for both total tendon point sensitivity and reactivity. All eighteen tender points were assessed for their activations and assigned a score for their sensitivities (0=no pain, 3=withdrawal of the patient
The rheumatologist was blinded as to which group the subject was participating. The tender point examinations occurred at the same time of day, 9-10 am, on three different Saturdays. One control and one strength-trained subject did not have the tender point evaluation, due to complications in scheduling and surgery, respectively. The control group tender point reactivity increased by 9% ($F(1,11)= .006, p>0.05$) while the strength-training group decreased by 25% ($F(1,6)= 1.855, p>0.05$), pre to post. The tender point sensitivity decreased by 7.2% ($F(1,11)= .492, p>0.05$) in the control group and decreased by 35.7% ($F(1,6)= 2.928, p>0.05$) in the strength-training group, pre to post. However, there were no significant differences between the two groups for either tender point reactivity or sensitivity following the intervention. This may have been attributed to the women’s day-to-day pain. This study did not attempt to control changes in medications or treatment modalities. The subjects in both groups were told to take whatever precautions they saw necessary to maintain their comfort and quality of life. The small sample size of the strength-training group could have affected the significance level as well. Another confounding variable is that we did not quantify flare-ups. Flare-ups are a common complaint of women with FMS and these flare-ups can last days to months (5,16).

Table 6. TOTAL TENDER POINT AND TOTAL MYALGIC SCORES BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=18).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL (n=11)</th>
<th>STRENGTH (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>tTP</td>
<td>11 ± 6</td>
<td>12 ± 5</td>
</tr>
<tr>
<td>tMyalgic</td>
<td>14 ± 8</td>
<td>13 ± 5</td>
</tr>
</tbody>
</table>

Values are means ± SD.

$tTP=$Total tender point reactivity.

$tMyalgic=$Total myalgic score, total overall sensitivity.

Martin (22) examined tender points for their reactivity and sensitivity for 60 subjects with FMS. The baseline score for the active tender points was 13±2, while the total sensitivity was 28±6. The number of active tender points for this study was similar to the baseline of Martin, 12±5. Following the strength-training and aerobic intervention Martin’s total tender point activity was reduced to 10±3 ($p<0.05$). However, Martin used a scale of 0-4 for tender point sensitivity rather then 0-3, which was used in the present study.

The Fibromyalgia Impact Questionnaire

Persons diagnosed with FMS complain of day-to-day pain and problems with ADL. The Fibromyalgia Impact Questionnaire (FIQ) consists of 20 questions that assess the impact of the syndrome on day-to-day life (15,22,24,31). Questions range from the ability to perform ADL, sleep, mood and day-to-day pain. Table 7 presents the values for the FIQ. Research has shown the average person with FMS scores 50 units out of 100 units, while a severely impacted person with FMS scores above 70 units (24). The baseline score for this study (55.2±17.5 units) was higher than seen in other studies (44.3±9 units) (24,31). Therefore, the subjects in the present study were more impacted by the syndrome then seen in previous studies. Rooks (31) following
16 weeks of aerobic and strength training demonstrated a decrease in the FIQ of 12.5±13.7 units (p<0.01); for a new score of 31.8±13.5 units (p<0.002).

Although the Two-way ANOVA did not find differences between the two groups, One-way ANOVA showed a significant decrease in FIQ for the strength-training group. The strength group decreased the score of the FIQ by 21.4% (F(1,7)=5.701, p≤0.05) and the control group decreased by 6% (F(1,11)=.516, p>0.05), pre to post. The impact of the syndrome may have been decreased by the intervention. The difference might not have been noted by the Two-way ANOVA due to the large amount of variation and the small sample size.

Table 7. FIBROMYALGIA IMPACT AS MEASURED BY THE FIBROMYALGIA IMPACT QUESTIONNAIRE (FIQ) BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=20).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL (n=12)</th>
<th>STRENGTH (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>FIQ</td>
<td>56.2 ± 12.3</td>
<td>52.7 ± 13.0</td>
</tr>
</tbody>
</table>

Values are means ± SD.
† p≤0.05 significantly different from pre test after 12 weeks of strength training.

Martin (22) also utilized the FIQ in a group of women with FMS. The baseline score for the study was 41.9±18.5 units. Following the six-week intervention the FIQ decreased to 38.9±15.0 units for a difference of 7%. This was not considered significant. Martin stated in the discussion that there was a trend towards a lower score on the FIQ but six weeks is probably not enough time to detect physiological changes in fibromyalgia impact.

Continuous Scale-Physical Functional Performance (Cs-PFP) Test

The key of strength-training interventions in some special populations is to improve the ability to perform ADL. Several studies utilizing measures of ADL have found strength training to improve functionality in frail elderly (8). Whether functionality in fibromyalgia is compromised or can be improved in FMS is unknown. The Cs-PFP utilizes 17 tests that range from pouring water from a jug into a cup, to carrying a weighted bag up steps. The tasks and results for the individual tasks are summarized in Table 8. The 17 tasks are ordered in their degree of difficulty. Heart rate, the time it takes to complete the task, the weight carried, the distance covered, and ratings of perceived exertion are measured as needed for each task.
Table 8. CONTINUOUS SCALE-PHYSICAL FUNCTIONAL PERFORMANCE TESTS (Cs-PFP) BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=19).

<table>
<thead>
<tr>
<th>Task</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONTROL (n=12)</td>
<td>STRENGTH (n=7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pan Carry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>3.9 ± 1.3</td>
<td>3.7 ± 1.0</td>
<td>3.7 ± 1.1</td>
<td>3.5 ± 1.0</td>
</tr>
<tr>
<td>Wt.</td>
<td>9.4 ± 4.2</td>
<td>8.3 ± 3.4</td>
<td>7.6 ± 2.8</td>
<td>10.8 ± 4.9†*</td>
</tr>
<tr>
<td>RPE</td>
<td>10 ± 3</td>
<td>11 ± 2</td>
<td>8 ± 3</td>
<td>8 ± 2</td>
</tr>
<tr>
<td>Water Pour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>8.7 ± 2.3</td>
<td>8.0 ± 2.1</td>
<td>9.0 ± 4.0</td>
<td>7.9 ± 2.9</td>
</tr>
<tr>
<td>RPE</td>
<td>8 ± 2</td>
<td>9 ± 2†</td>
<td>7 ± 1</td>
<td>7 ± 2</td>
</tr>
<tr>
<td>Jacket</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>12.6 ± 3.3</td>
<td>12.1 ± 2.5</td>
<td>11.6 ± 1.9</td>
<td>10.0 ± 1.2</td>
</tr>
<tr>
<td>RPE</td>
<td>7 ± 2</td>
<td>8 ± 2</td>
<td>6 ± 1</td>
<td>6 ± 1</td>
</tr>
<tr>
<td>Shoe Strap</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>7.3 ± 2.1</td>
<td>6.5 ± 1.9</td>
<td>6.9 ± 1.9</td>
<td>5.1 ± 1.1†</td>
</tr>
<tr>
<td>RPE</td>
<td>8 ± 2</td>
<td>9 ± 3</td>
<td>7 ± 1</td>
<td>6 ± 1</td>
</tr>
<tr>
<td>Scarves</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>9.4 ± 4.5</td>
<td>7.7 ± 2.5</td>
<td>7.5 ± 3.1</td>
<td>5.8 ± 1.3*</td>
</tr>
<tr>
<td>RPE</td>
<td>9 ± 2</td>
<td>9 ± 2</td>
<td>7 ± 2</td>
<td>7 ± 1</td>
</tr>
<tr>
<td>Reach</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ht.</td>
<td>211.8 ± 9.4</td>
<td>211.3 ± 9.0</td>
<td>211.6 ± 9.1</td>
<td>209.2 ± 16.5</td>
</tr>
<tr>
<td>RPE</td>
<td>10 ± 2</td>
<td>10 ± 2</td>
<td>8 ± 2</td>
<td>8 ± 2</td>
</tr>
<tr>
<td>Sweep</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>31.7 ± 14.0</td>
<td>29.4 ± 9.6</td>
<td>30.9 ± 13.7</td>
<td>25.2 ± 9.9</td>
</tr>
<tr>
<td>RPE</td>
<td>11 ± 2</td>
<td>10 ± 3</td>
<td>9 ± 2</td>
<td>8 ± 3†</td>
</tr>
<tr>
<td>Laundry 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>27.9 ± 9.2</td>
<td>25.9 ± 8.8</td>
<td>27.9 ± 7.5</td>
<td>24.3 ± 4.7</td>
</tr>
<tr>
<td>RPE</td>
<td>11 ± 1</td>
<td>10 ± 2</td>
<td>10 ± 2</td>
<td>8 ± 2</td>
</tr>
<tr>
<td>Laundry 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>19.6 ± 4.8</td>
<td>18.2 ± 6.2</td>
<td>20.4 ± 5.4</td>
<td>16.5 ± 3.9</td>
</tr>
<tr>
<td>RPE</td>
<td>10 ± 2</td>
<td>10 ± 2</td>
<td>9 ± 2</td>
<td>8 ± 2</td>
</tr>
<tr>
<td>Bed Making</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>78.0 ± 24.9</td>
<td>64.8 ± 19.6†</td>
<td>81.4 ± 25.8</td>
<td>72.4 ± 23.9</td>
</tr>
<tr>
<td>RPE</td>
<td>12 ± 2</td>
<td>12 ± 3</td>
<td>11 ± 3</td>
<td>9 ± 2† 8</td>
</tr>
<tr>
<td>Vacuum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>52.5 ± 16.1</td>
<td>40.0 ± 13.5</td>
<td>48.5 ± 11.0</td>
<td>33.3 ± 7.1†</td>
</tr>
<tr>
<td>RPE</td>
<td>11 ± 1</td>
<td>11 ± 2</td>
<td>12 ± 3</td>
<td>9 ± 3*</td>
</tr>
<tr>
<td>Floor Sit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>11.2 ± 4.0</td>
<td>11.4 ± 4.2</td>
<td>8.8 ± 2.9</td>
<td>6.9 ± 2.1γ</td>
</tr>
<tr>
<td>RPE</td>
<td>12 ± 3</td>
<td>14 ± 3</td>
<td>10 ± 2</td>
<td>10 ± 3*</td>
</tr>
<tr>
<td>Fire Door</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>2.8 ± 1.1</td>
<td>3.6 ± 1.2†</td>
<td>2.5 ± 1.3</td>
<td>2.8 ± 0.7</td>
</tr>
<tr>
<td>RPE</td>
<td>8 ± 3</td>
<td>8 ± 2</td>
<td>7 ± 2</td>
<td>6 ± 0.0</td>
</tr>
</tbody>
</table>
The strength-training group had significant improvements in many of the individual tasks of the Cs-PFP. The amount of weight carried was significantly different from the control group in all three tasks where additional weight was used; the weighted pan carry (F(1,18)=43.012, p≤0.05), the weighted bag in the bus stop task (F(1,18)= 33.842, p≤0.05), and the grocery bags in the grocery store task (F(1,18)=20.357, p≤0.05). The time to complete the task was significantly different following the 12-week intervention in the strength-training group compared to the control group for one task, the scarves task (F(1,18)= 5.424, p≤0.05). The ratings of perceived exertion was lower for the first laundry task (F(1,18)= 5.797, p≤0.05), the floor sit task (F(1,18)= 2.767, p≤0.05) and the 6-minute walk (F(1,18)= 19.908, p≤0.05) for the strength-training group compared to the control. This demonstrates that the subjects found these tasks to be easier following the strength training intervention.

Surprisingly, heart rate was significantly different between the two groups after the 12 weeks for one of the tasks, the shoe strap task. The subjects also perceived it to be easier, although not significant. This task requires muscular flexibility. Even though the subjects did not complete the task any faster, it appeared not to be as physically demanding.
Scoring for the Cs-PFP is comprised of 5 domains representing upper body strength, upper body flexibility, lower body strength, balance and coordination, and endurance. The five domains are then averaged to derive a Cs-PFP total score. Each domain is derived by measuring either the time it takes to complete the task, the weight carried, the distance covered or sometimes all three. This test has been shown to be valid and reliable in elderly men and women (7).

Table 9 presents the values for the domains and Cs-PFP total score. The strength-training group had a significant increase compared to the control group in the upper body strength domain (F(1,18)=12.482, p≤0.05), the lower body strength domain (F(1,18)=8.363, p≤0.05), Cs-PFP total score (F(1,18)=6.606, p≤0.05) and a decrease in overall RPE (F(1,18)=5.434, p≤0.05), post to post. The upper body strength domain increased by 21.2% (F(1,6)=11.441, p≤0.05); and the lower body strength domain increased by 27.5% (F(1,6)=16.063, p≤0.05) following 12-weeks of strength training, pre to post. The overall RPE decreased from 11±3 to 10±3 (F(1,6)=7.364, p≤0.05), pre to post. The Cs-PFP total score increased by 18.7% (F(1,6)=12.265, p≤0.05) in the strength-training group, pre to post. There was also a trend for the endurance component of the Cs-PFP to increase (F(1,18)=3.984, p=0.09). The strength-training program focused on strength; however, it may be that endurance may be somewhat limited by a lack of muscular strength in the lower legs.

A one-way ANOVA demonstrated a significant increase, pre to post, in the total Cs-PFP score (F(1,6)=12.265, p≤0.05) and all of the domains for the test (UBS: (F(1,6)=11.441, p≤0.05); LBS (F(1,6)=16.063, p≤0.05); UBF: (F(1,6)=7.990, p≤0.05); END: (F(1,6)=9.271, p≤0.05)) except for the balance and coordination domain. There was also a decrease in overall RPE (F(1,6)=7.364, p≤0.05) for the strength-training group, pre to post. The control group had only a significant increase in one of the domains, balance and coordination (F(1,11)=13.713, p≤0.05), pre to post. The reason for the increase in the balance and coordination domain for the control group is unknown. The significant increase for the strength-training group in upper body flexibility was also unexpected. However, the strength training exercises do help improve range of motion especially the overhead press that may have helped the subjects improve their reaching ability and moving their arms to put on a jacket.

Table 9. CONTINUOUS SCALE-PHYSICAL FUNCTIONAL PERFORMANCE TEST (Cs-PFP) DOMAINS BEFORE AND AFTER 12 WEEKS OF STRENGTH TRAINING IN WOMEN WITH FIBROMYALGIA (N=19).

<table>
<thead>
<tr>
<th></th>
<th>CONTROL (n=12)</th>
<th>STRENGTH (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>UBS</td>
<td>50.2 ± 11.5</td>
<td>48.6 ± 12.9</td>
</tr>
<tr>
<td>UBF</td>
<td>67.3 ± 10.5</td>
<td>67.2 ± 18.3</td>
</tr>
<tr>
<td>LBS</td>
<td>43.9 ± 14.5</td>
<td>48.7 ± 16.3</td>
</tr>
<tr>
<td>BALC</td>
<td>47.9 ± 14.4</td>
<td>55.4 ± 15.3†</td>
</tr>
<tr>
<td>END</td>
<td>55 ± 15.9</td>
<td>58.8 ± 16.8</td>
</tr>
<tr>
<td>Cs-PFP Total</td>
<td>51.3 ± 13.6</td>
<td>54.8 ± 15</td>
</tr>
<tr>
<td>Overall RPE</td>
<td>12 ± 1</td>
<td>13 ± 2</td>
</tr>
</tbody>
</table>

Values are means ± SD.
All values are measured in units.
† p≤0.05 significantly different from pre test after 12 weeks of strength training.
* p≤0.05 significantly different from control group after 12 weeks of strength training.
UBS=Upper Body Strength Domain.
UBF=Upper Body Flexibility Domain.
LBS=Lower Body Strength Domain.
BALC=Balance and Coordination Domain.

An important point is that this study focused on strength and its effect on functionality. Both of the strength domains (UBS, LBS) were significantly different between the two groups, which was expected. The improvement in strength did correlate with improvements in functionality as expressed by the Cs-PFP total score.

Karper (16) used four tests to determine functionality following an aerobic and strength-training intervention in women with FMS with an average age of 53±5 years. Subjects performed 1 set of 8-10 repetitions with 1-8 pound dumbbells. Subjects performed strength and aerobic training 3-days a week. The functionality tests included chair-stand test, chair sit-and-reach test, back scratch test, and the 8-feet get-up-and-go test. Following the intervention subject’s performance on all the ADL improved. This study supports the finding by Karper (16).

An exercise intervention by Cress (8) utilized 75 ±5 year old healthy, men and women. The subjects underwent training three days a week at 65-85% of their predicted 1-RM. Their baseline score for the Cs-PFP total was 54.2±14 units. Following Cress’ intervention, the Cs-PFP total score increased to 62.8±7.4 (8). In this study, the Cs-PFP total score increased to 64.5±13.4 units. In the present study scores ranged from 29 to 80 units prior to the intervention. This study had women, 30 years younger, with a lower Cs-PFP total score at baseline then the subjects in the study by Cress.

A recent study from Cress (9), has demonstrated that a Cs-PFP total score of less then 57 units may compromise the ability to live independently. Cress used men and women ages 65-97 yr. (9). In the present study, the mean of the total score for the Cs-PFP test for the FMS subjects was well below the threshold determined by Cress for both the control and strength-training. Following the intervention, the mean for the strength-training group increased above the threshold, 64.5±13.4 units. The mean for the control group was still below the threshold, 54.8±15 units. The FMS subjects in both groups, the control and strength training, had made changes in their daily activities to compensate for their decreased ability prior to the study. Top shelves had been moved lower to avoid reaching overhead. Housework was shared with other family members, to avoid fatigue and pain. Therefore, women with FMS suffer with limitations in the ability to perform ADL.

Improvements in ADL are very important in this population. Most of the individuals with FMS experience forced retirement and live through ever-changing, day-to-day pain. Their ADL are restricted. Their feelings of self-worth and independence have been compromised to the point that they may become co-dependent. Any increase in ADL may provide these individuals with more independence and increased feelings of self-worth. Therefore, strength training appears to be a very important component for improving functional capacity in persons living with FMS.
CHAPTER 5
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Persons with FMS demonstrate lower muscle strength and endurance. These symptoms result in exercise intolerance and limitations on the ability to perform ADL. Aerobic exercise interventions have demonstrated reductions in symptomology, including decreases in sleep disturbances, decreases in feelings of pain, and increases in the ability to cope with pain. However, aerobic interventions do not address the issues of muscle atrophy and weakness, and the subsequent decreases in ADL. Research on functionality thus far has been limited. Therefore, the purpose of this study is to determine if a 12-week progressive, full body strength-training program will improve muscular strength and endurance, body composition, tender point sensitivity, fibromyalgia impact, and functionality in women diagnosed with FMS.

Twenty volunteers from the Tallahassee area were recruited for this study and were placed into one of two groups, either a control group or a strength-training group. The study’s protocol required subjects to participate in a series of tests, both before and after the 12-week training period. These tests included maximal strength, body composition, tender point assessment for reactivity and sensitivity, disease impact, and the ability to perform ADL by utilizing the Cs-PFP. Each of the groups was provided with separate protocols for the 12 weeks. The subjects in the control group were asked not to change their current levels of activity, while the strength-training group performed 11 exercises, twice a week starting at 40% of 1-RM and progressing to approximately 60-80% of 1-RM.

Conclusions

First, it can be concluded that the addition of a strength-training program can be well tolerated by persons with FMS. There were no significant differences between the groups at the beginning of the study on the measured variables. Homogeneity between groups in persons with FMS is rare because the disease has such a large spectrum of effect. The following is a summary of the significant findings derived from each group as they relate to the seven hypotheses.

Three of the seven hypotheses that were proposed for the strength-training group were supported. Maximal strength as measured by upper body and lower body 1-RM were significantly different, concurring with the hypothesis. Body composition was unaltered in the strength-training group. There was no change in lean mass, which rejected the hypothesis. Bone mineral density was also unaltered in the strength-training group, which supported the hypothesis. Again, the duration of the study was 12 weeks, probably not enough time for increases in bone mineral density. The strength-training group was hypothesized to have improvements in both tender point reactivity and sensitivity. Neither of these hypotheses was supported. The small sample size and flare-ups may have affected these measures. However, even though there was not a statistically significant difference in tender point reactivity and sensitivity there was a 9% increase in sensitivity in the control group and a 25% decrease in sensitivity in the strength-training group. These differences although not statistically significant may have dramatic physiological consequences in these women. Anecdotal reports from the women seemed to suggest they were experiencing a great deal of improvement in pain and felt
much better during the strength training program. Total myalgic score showed a 36% improvement while the control group only improved by 8%. The FIQ was hypothesized to decrease in the strength-training group. There was a trend towards a lower score but, the small sample size and/or flare-ups may have affected this measure. Again, there was a 21% decrease in FIQ and only a 6% decrease for the control group. Although not statistically different, the physiological difference to the training group may play an important role in the lives of the women with FMS. Improvements in ADL were hypothesized to occur for the strength-training group. This hypothesis was supported. The strength-training group had a significantly different Cs-PFP total score as well as scores for the UBS domain and the LBS domain. Improvements in heart rate, the weight carried and the time to complete the tasks were improved for some of the tasks.

In conclusion, the findings of this study suggest that the addition of a progressive, full-body, strength-training program for the treatment of fibromyalgia may increase maximal strength, and improve the ability to perform ADL. The ability to perform ADL is essential to maintain quality of life. Fibromyalgia is much like aging, not only physically but also mentally. Strength-training increases physical strength, but it may also increase feelings of self-worth. The strength-training program was well tolerated by all of the subjects. This study suggests that strength training is a useful addition to any therapy for the treatment of FMS.

Recommendations for Future Research

There are several recommendations that can be made concerning future research for persons with FMS. The first recommendation is that more research needs to address the issue of functionality. Reducing pain and the impact of the disease is important. However, if pain and impact are reduced, it does not necessarily mean an increase in functionality. Large sample sizes are needed to ensure homogeneity among groups and to normalize the subject groups.

Another recommendation is that there needs to be more research utilizing exercise interventions, both aerobic and strength, in this population. The research on aerobic activity has increased more so than strength training research. For this population both are important factors in treating the symptoms of the disease. Ultimately, more research is needed on exercise interventions and exercise.

No study has used the Cs-PFP for persons with FMS. More studies using this standardized ADL protocol are needed. Research has demonstrated that ADL are compromised in FMS. The Cs-PFP needs to be performed on a large scale, with lots of subjects to determine its validity in this population. Interventions that wish to measure ADL could use the Cs-PFP because it is standardized. This would give researchers more of an idea of what they are dealing with, and how their subject pool compares to the larger community of persons with FMS.

The amount of exercise that can be tolerated by this group has not yet been published. Longitudinal studies need to be completed with strength-training interventions to determine the most appropriate modality, frequency, intensity, and volume of training needed. Longitudinal studies need to address the issue of how and if FMS progresses through the aging process. Research needs to answer whether or not strength training can maintain or improve functional performance and quality of life over the life span.
Recommendations for Strength Training Persons with FMS

Based on the results of the present study and the results of previous research it is recommended that strength training become a treatment modality for persons with FMS. This study utilized a linear circuit, where the exercises were held constant with an increase in weight every three days. By the end of the study, the weight on some exercises had become almost too heavy for some of the participants. Perhaps an undulating circuit would be more appropriate, where the exercises vary, and weight remains relatively constant. A variety of exercises may prevent burnout and keep the exercisers motivated. Flare-ups are an inevitable fact for persons with FMS therefore intensity levels need to be reduced during flare-up periods or range of motion exercises should replace the weight exercises until the flare-ups have subsided. Nonetheless, a progressive, full-body strength-training program may aid in increasing maximal strength and improve ADL. Observations from this study indicate that the lower repetitions, fewer than 10, were better tolerated than higher repetitions, greater than 10. Also, the overhead press was difficult for many of the subjects in this study due to pain in the trapezius and at the occiput. Perhaps performing lateral raises to work the shoulders instead of the overhead press may reduce neck pain. However, the overhead press does improve the strength of reaching overhead which is compromised in patients with FMS. The use of the RPE following each training session aided in determining when the subjects were pushing too hard. Pushing hard may be beneficial, but over doing it may have serious complications. This study demonstrated that the addition of a strength-training program is safe and may increase the ability to perform ADL, thereby increasing independence and increasing the quality of life for persons with FMS.
APPENDIX A:
INSTITUTIONAL REVIEW BOARD (IRB)
APPROVAL MEMORANDUM
from the Human Subjects Committee

Date: June 20, 2002

From: David Quadagno, Chair

To: Lynn Panton
Dept: Nutrition, Food and Exercise Sciences
Re: Use of Human subjects in Research
    Project entitled: The Effects of Strength and Aerobic Conditioning on Strength, Aerobic Capacity, Body Composition, Pain, Fatigue and Functionality in Women with Fibromyalgia

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Human Subjects Committee at its meeting on June 13, 2002. Your project was approved by the Committee.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals which may be required.

If the project has not been completed by June 12, 2003, you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

APPLICATION NO. 02.296
cc: Derek Kingsley (NFMS), Tonya Toole (NFMS), Bob Moffatt (NFMS)
APPENDIX B: INFORMED CONSENT
INFORMED CONSENT FORM

1. I freely and voluntarily and without element of force or coercion, consent to be a participant in the research project entitled “The Effects of Strength and Aerobic Conditioning on Strength, Aerobic Capacity, Body Composition, Pain, Fatigue, and Functionality in Women with Fibromyalgia.” This research is being conducted by Lynn Panton, Ph.D., Tonya Toole, Ph.D., and Derek Kingsley who are faculty members and a graduate student, respectively, at Florida State University in the Department of Nutrition, Food and Exercise Sciences.

2. The purpose of the research project is evaluate the effects of strength and aerobic conditioning on strength, aerobic capacity, body composition, pain, fatigue, and functionality in women with Fibromyalgia. Thirty women 18-54 years of age diagnosed with Fibromyalgia will be recruited for this study.

3. My participation in this project will involve coming to the Laboratory of Aging, Motor Behavior, and Functional Performance at Florida State University on five different occasions before and after an exercise intervention or control period to undergo the following tests described below.

   On the first visit I will be oriented to the study, sign an informed consent, and complete questionnaires on demographics, health history, tobacco history, physical activity, quality of life, and pain indices. This should take approximately one hour.

   On the second visit height, weight, blood pressure, bone density, tender point sensitivity, muscular strength and endurance will be measured. Height and weight will be assessed using a standardized scale. Blood pressure will be measured in a quiet room on my forearm after I have been seated for a period of 5 minutes. Bone density will be evaluated by Dual-Energy X-ray Absorptiometry (DEXA). This involves some radiation this is comparable to the radiation a person receives from a chest X-ray, but substantially less than a full dental X-ray or an abdominal X-ray. The measurement of bone mineral using the DEXA is non-invasive. I will lie on a padded table for approximately 15 minutes while the scan is being completed. Tender point sensitivity will be evaluated by a certified Rheumatologist. The Rheumatologist will apply pressure with his hands on 18 areas that will include the back of the neck, shoulders, hips, legs, and the front of the neck, shoulders, elbows, and knees. I will tell the Rheumatologist whether these areas are sensitive or sore with touch. Upper and lower body strength will be assessed using the Biodex Isokinetic Strength System. I will be asked to sit in a machine and push as hard as I can against a leg or arm pad. This will assess how strong I am. This visit will take approximately two hours.

   On the third visit, I will be evaluated for resting blood pressure and strength measurements. Blood pressure and strength measurements will be measured again to verify previous results. This visit will take approximately forty-five minutes.

   On the fourth visit, I will complete the Continuous Scale–Physical Functional Performance (CS-PFP) test. The CS-PFP test consists of tasks that simulate activities of daily living. The tasks will include carrying a weighted pan, pouring water into a cup, putting on shoes, picking up scarves,
putting on a jacket, reaching, floor sweeping, doing laundry, bed making, vacuuming, sitting and standing from the floor, opening a fire door, stair climbing, getting on a bus, carrying groceries, and walking for 6 minutes. Measurements will be taken on the time it takes to complete the individual tasks. I may stop and rest at any time during the test. I may also choose not to do any portion of this test if I feel uncomfortable about an activity. My heart rate will be monitored during this test. This visit will take approximately one hour and thirty minutes.

On the fifth visit, I will undergo a maximal aerobic test to determine how physically fit I am. The maximal aerobic test will be completed while I am walking on a treadmill. I will be asked to walk as long as I can. When I become fatigued and cannot walk any longer the test will be stopped. During the test, heart rate and blood pressure will be monitored. The speed of the treadmill will be maintained at 3.5 mph and the grade will be increased every two minutes by 2.5%. Maximal aerobic capacity will be measured by placing a mouthpiece into my mouth and collecting expired air. The air that is collected is analyzed and is used to calculate the energy that the body uses during exercise. This visit will take approximately one hour and thirty minutes.

After I complete all testing I will randomized into one of three groups, a strength training, an aerobic training, or a control group. If I am in the strength-training group I will perform 12 strengthening exercises using resistance machines three times per week at Premier Health Club. I will perform 3 sets of 8-10 repetitions on each of the 12 strength-training exercises. Exercises will include biceps curl, triceps extension, shoulder raises, chest press, overhead press, leg extensions, leg curls, calf raises, squats, leg abduction and adduction, and abdominal crunches. Once 10 repetitions can be completed on each set of a specific exercise the weight of that machine will be increased by 5lbs for the upper body or 10lbs for the lower body. If I am placed in the aerobic group I will also train three times a week at Premier Health Club but will exercise on aerobic machines at 50-60% of maximal heart rate (the maximal heart rate that I achieved during the aerobic test) for 20-30 minutes for the first month, 60-70% of maximal heart rate for 30-40 minutes for the second month, and 70-80% of maximal heart rate for 40-50 minutes for the third month. I will be supervised during all training sessions. If I am placed in the control group I will be asked not to change my lifestyle during the three-month control period. After the completion of the post testing I will be given the opportunity to train at Premier Health Club. At the end of the three months of training or control period all the tests described above will be repeated.

4. I understand there is a possibility of a minimal level of risk involved if I agree to participate in this study. The risks will be minimized by using trained technicians and by teaching me proper techniques in testing and training. I will complete a medical history before I can participate in the study. I will not be able to participate in this study if I have a history of myocardial infarction, stroke, type I diabetes mellitus, uncontrolled hypertension (160/100 mmHg or more), or any other condition that may be contraindicated for exercise testing and training.

There are minimal risks or discomfot with answering the enclosed questionnaires. I may choose not to complete the questionnaires and will still be able to participate in the study.
The CS-PFP test is safe and no adverse conditions have been reported (personal communication with Dr. Cress). I will be instructed to perform each task at maximal effort within the bounds of safety and comfort. Heart rate monitors will be worn during the duration of the test and blood pressure will be measured before testing is initiated and once again when testing is completed. I may stop the test at anytime to rest or get drinks of water. Juice will also be made available in case I need to have a drink with sugar in it. I may choose not to complete a task if I feel uncomfortable. I will wear a transfer belt during the CS-PFP test that will allow the technician to support me when I do some of the different tasks such as moving from the floor to a standing position. My heart rate will be monitored throughout this test.

I might experience some muscle soreness from strength testing and training. Care will be taken to try and minimize soreness by thoroughly stretching. The risk of cardiovascular events during the aerobic stress test and training period will be minimized by careful review of my medical history and monitoring of my exercise sessions.

5. The possible benefits of my participation in this research project include learning about my fitness levels and how exercise affects Fibramyalgia. I will also be given a number of tests free of charge and the results will be given to me and my physician if I wish.

6. The results of this research study may be published but my name or identity will not be revealed. Information obtained during the course of the study will remain confidential, to the extent allowed by law. My name will not appear on any of the results. No individual responses will be reported. Only group findings will be reported in publications. Confidentially will be maintained by assigning each subject a code number and recording all data by code number. The only record with the subject’s name and code number will be kept by the principal investigator, Lynn Panton, in a locked drawer in her office. Data will be kept for 10 years and then destroyed.

7. In case of an injury first aid will be provided to me by the laboratory personnel working on the research project any other treatment or care will be provided at my expense.

8. I will not be paid for my participation in this research project.

9. Any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by the investigators or they will refer me to a knowledgeable source. I understand that I may contact Dr. Lynn Panton at work (850) 644-4685 or at home (850) 893-3159 for answers to questions about this research project or my rights. Group results will be sent to me upon my request.

10. In case of injury, or if I have questions about my rights as a subject/participant in this research, or if I feel I have been placed at risk, I can contact the chair of the Human Subjects committee, Institutional Review Board, through the Office of the Vice President for Research, at (850) 644-8633.

11. The nature, demands, benefits and risks of the project have been explained to me. I knowingly assume any risks involved.
I have read the above informed consent form. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefits to which I may otherwise be entitled. In signing this consent form, I am not waiving my legal claims, rights or remedies. A copy of this consent form will be given to me.

(Signature)
(Date)

(Witness)
(Date)
APPENDIX C:
ONE-REPTITION MAXIMAL STRENGTH TESTING
Subject Number

Date
Chest Press 1-RM
Leg Extension 1-RM

Date
Chest Press 1-RM
Leg Extension 1-RM

Date
Chest Press 1-RM
Leg Extension 1-RM

Date
Chest Press 1-RM
Leg Extension 1-RM
APPENDIX D:
GRIP STRENGTH
| Subject ID | __________ |
| Tester     | __________ |
| Date       | __________ |
| Height     | __________ |
| Weight     | __________ |

**Circumferences**

| Waist      | __________ |
| Hip        | __________ |

**Handgrip Strength**

| Right      | __________ | __________ | __________ |
| Left       | __________ | __________ | __________ |
APPENDIX E:
TENDER POINT ASSESSMENT
## The Florida State University
### Tender Point Assessment

<table>
<thead>
<tr>
<th>Subject number</th>
<th>Year Diagnosed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Tender Point Sensitivity</td>
</tr>
<tr>
<td></td>
<td>Right</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tender Point</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occiput</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low cervical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trapezius</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraspinatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second rib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral epicondyle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gluteal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater trochanter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Occiput**: At the suboccipital muscle insertions.
- **Low cervical**: At the anterior aspects of the intertransverse spaces at C5-C7.
- **Trapezius**: At the midpoint of the upper border.
- **Supraspinatus**: At origins, above the scapula spine near the medial border.
- **Second rib**: At the second costochondral junctions, just lateral to the junctions on upper surfaces.
- **Lateral epicondyle**: At 2 cm distal to the epicondyles.
- **Gluteal**: At upper outer quadrants of buttocks in anterior fold of muscle.
- **Greater trochanter**: At posterior to the trochanteric prominence.
- **Knee**: At the medial fat pad proximal to the joint line.
APPENDIX F:
FIBROMYALGIA IMPACT QUESTIONNAIRE
FIBROMYALGIA IMPACT QUESTIONNAIRE (FIQ)

Name: _________________________________    Date: / /

Directions: For questions 1 through 11, please circle the number that best describes how you did overall for the past week. If you don't normally do something that is asked, cross the question out.

Always Most Occasionally Never

Were you able to:

Do shopping? ......................................... 0 1 2 3
Do laundry with a washer and dryer? ....... 0 1 2 3
Prepare meals? ................................. 0 1 2 3
Wash dishes/cooking utensils by hand?..... 0 1 2 3
Vacuum a rug?....................................... 0 1 2 3
Make beds? ............................................ 0 1 2 3
Walk several blocks? ......................... 0 1 2 3
Visit friends or relatives? .................... 0 1 2 3
Do yard work? ....................................... 0 1 2 3
Drive a car? ............................................ 0 1 2 3
Climb stairs? ............................................ 0 1 2 3

12. Of the 7 days in the past week, how many days did you feel good?
0 1 2 3 4 5 6 7

13. How many days last week did you miss work, including housework, because of fibromyalgia?
0 1 2 3 4 5 6 7
FIBROMYALGIA IMPACT QUESTIONNAIRE (FIQ) – page 2

Directions: For the remaining items, mark the point on the line that best indicates how you felt overall for the past week.

14. When you worked, how much did pain or other symptoms of your fibromyalgia interfere with your ability to do your work, including housework?

● ____________

No problem with work Great difficulty with work

15. How bad has your pain been?

● ____________

No pain Very severe pain

16. How tired have you been?

● ____________

No tiredness Very tired

17. How have you felt when you get up in the morning?

● ____________

Awoke well rested Awoke very tired

18. How bad has your stiffness been?

● ____________

No stiffness Very stiff

19. How nervous or anxious have you felt?

● ____________

Not anxious Very anxious

20. How depressed or blue have you felt?

● ____________

Not depressed Very depressed
APPENDIX G:

Cs-PFP DATA REDUCTION FORM
**Data Collection Sheet**

<table>
<thead>
<tr>
<th>TASK</th>
<th>HR</th>
<th>TIME</th>
<th>WEIGHT</th>
<th>HEIGHT</th>
<th>Misc.</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight Carry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pouring</td>
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<td></td>
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<tr>
<td>Jacket</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sm Med Lg XL</td>
<td></td>
</tr>
<tr>
<td>Shoe Strap</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scarves</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RIGHT LEFT</td>
<td></td>
</tr>
<tr>
<td>Floor Sweep</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laundry 1</td>
<td></td>
<td></td>
<td>4.09 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laundry 2</td>
<td></td>
<td></td>
<td>4.09 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bed Making</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum</td>
<td></td>
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<td></td>
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<tr>
<td>Floor Sit</td>
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<tr>
<td>Fire Door</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Groceries</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Stair Climb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td># stairs</td>
<td></td>
</tr>
<tr>
<td>TOTAL PFP TIME</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall PFP RPE</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Special Considerations: (if yes, ask if it is chronic or if today is different, log)
End of test: log anything unusual about any specific task or overall.

Data entry _______

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REFERENCES


BIOGRAPHICAL SKETCH

JAMES DEREK KINGSLEY

Personal Data:  
Date of Birth:  April 19, 1976  
Place of Birth:  Greensboro, NC  
Marital Status:  Single

Education:  
The University of North Carolina at Greensboro, Greensboro, NC;  
The Florida State University, Tallahassee, Fl; Exercise Physiology  

Professional Experience:  
Professional Fitness Trainer; Maximum Potential, Greensboro,  
Graduate Research Assistant; The Florida State University,  
Tallahassee, Fl; August 2001-May 2003.

Activities:  
Certified CPR/First Aid/AED Instructor  
Member of the National Strength and Conditioning Association  
Member of the American College of Sports Medicine

Presentations:  
between Total Myalgic Score, Fibromyalgia Impact,  
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Poster Presentation at Regional ACSM (2003): “Relationships of  
Continuous Scale-Physical Functional Performance Indices  
(Cs-PFP) to Gait and Balance Parameters in Older  
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Physical Functional Performance Test in Older Women.”

of Functionality between Older Women and Women  
Diagnosed with Fibromyalgia Utilizing the Cs-PFP.”