POSITIVE IMPACT OF WEIGHT RESISTANCE TRAINING IN MS PATIENTS DESPITE VARIED DISABILITY LEVELS

Abstract

Outcome data were evaluated related to strength and endurance before and after completion of a six-month program of weight resistance exercise by MS patients at "Fast Forward Gym" in Omaha, Nebraska. This study is unique because MS patients with all levels of disability are evaluated for a change in strength and endurance despite the degree of their original disability. Results demonstrate that all individuals with MS, despite disability levels show parallel improvement in both strength and endurance. The study supports the use of exercise, specifically to include weight resistance programs, for all MS patients.

Introduction

Muscle weakness and fatigue have long been hallmarks of multiple sclerosis (MS). The effects of psychological and physical stress on MS are controversial (Heesen et al., 2003) but stress is generally accepted to be an important factor in the fatigue associated with the disease. Individuals with MS were advised in the past not to exercise, because exercise was believed to bring on fatigue.

Contrary to this historic opinion, muscles weakened by MS appear to improve from strength training programs. This improvement in strength can make daily activities less fatiguing and decrease the degree of disability ©. Exercise is now an important part of the symptomatic treatment of MS. There is, however, some indication that exercise may go beyond symptomatic treatment and could impact the disease state itself. Recent studies make it clear that MS patients benefit from physical exercise with profound effects on immune and endocrine parameters (Heesen et al., 2003; Reitberg et al, 2005; Schulz et al., 2004).

The objective of this study was to evaluate the effectiveness of weight resistance exercise in a group of MS patients followed by the MS Clinic of The Nebraska Medical Center. This was a retrospective evaluation of specific outcome measures related to strength and endurance before and after completion of a six-month program of weight resistance exercise. Unlike previous research studies, all levels of MS patients, even those with significant disability were evaluated for change in strength and endurance despite the degree of their original disability.

Methods

Specific strength and endurance outcome measures (see Table 9) were evaluated for designated muscle groups, following a six- month weight resistance program developed for MS patients.

The study population consisted of consecutive MS patients at The University of Nebraska Medical Center Multiple Sclerosis Clinic, recommended for exercise therapy to include a specific regime of conditioning and strength training at Fast Forward Gym, Omaha, NE. Individuals were included irrespective of their EDSS score on entry. Subjects had to complete at least 6 months of regular continuous exercise intervention to be included in the study.

The study received approval from The Nebraska Medical Center Institutional Review Board (IRB). (See Appendix A).

Inclusion Criteria

1. Subjects were patients at the University of Nebraska Medical Center Multiple Sclerosis Clinic.
2. Subjects met all required areas of McDonald criteria for a diagnosis of laboratory supported MS.
3. Subjects were willing to complete a 6 month exercise program at Fast Forward Gym, Omaha, NE.

General demographic information on all subjects was collected from the medical records of The Nebraska Medical Center MS Clinic to insure that the study population was consistent with the general population of MS patients and to evaluate whether weight resistance exercise was more effective in MS patients with low disability than those with moderate or severe disability. The demographic data included: gender, age, age at diagnosis, time since diagnosis of MS, type of immunotherapy for MS (if any) at the time of participation in the exercise program and number of relapses (if any) during the 6 month weight resistance study period. The disability level of the MS patients at the time the exercise program was prescribed was recorded by placement into one of three groups:

1. able to walk without aid, EDSS 1-4.5,
2. able to walk with an aid (cane or orthotic device), EDSS 5-7, or
3. unable to walk 25 feet, wheelchair confined, EDSS 7.5 or above.

Weight resistance exercise outcome data were collected from training records at three time points (at the initiation of the weight resistance exercise program and after 3 and 6 months in the program). The data included the following:

a. strength: maximum pounds lifted over period of time

b. endurance: measurement of output at certain stations recorded as repetitions with specific low weights over a set time period.

A full compliment of dynamic stretching exercises was done as a warm-up and a static stretch was performed after the main program, involving the arms; shoulders, calves, hamstrings, and quadriceps. A variation of all the stretches could be performed standing, sitting in a chair, or on a floor mat. The program breakdown consisted of: 5-10 minutes of warm-up (dynamic stretch), 30 minutes of strength circuit and 5-10 minutes of cool down (static stretch).

The entire training program consisted of three phases over a 3-day period. Trainers assisted with one-on-one help as needed during the workouts. Records, let participants track their improvements, encouraging them to continue but not overdo.

The first day focused purely on strength improvement, with the participants spending the entire time on stationary machines, with each machine working different areas, including the back (upper and lower), shoulders, chest triceps, biceps, abdominals and legs. Machines were modified and arranged to allow wheelchair accessibility when possible.

The second day the time was divided between the machines and exercises to improve balance and dexterity. Balance exercises were conducted in squat cages, providing stability, and security, allowing the participants to work on balance, strength and conditioning. A combination of dumbbells, Swiss balls, and balance boards were used to increase conditioning, agility and strength.

The third phase used free weight movements. Each participant utilized weight benches to complete their activity, with balance and coordination as the goal. The goal of each phase was to recognize and improve on the imbalance problems MS often causes. Each activity was completed unilaterally to ensure the stronger body parts were not assuming all the work.

The program was circuit based with each participant completing 2-3 sets of approximately 10 repetitions at each exercise station before moving onto the next. This was done to reduce any undue physical fatigue caused by rapidly moving between stations. Ten exercise stations made up each circuit. Completing multiple sets on each station with limited rest between each set allowed for the anaerobic benefits that result from strength training. The limited rest between exercises allowed the heart rate to remain elevated throughout the duration of the routine.

All exercises were modified to fit the participant and their unique abilities, including those with EDSS scores of over 7.5. Data were collected on all activities, including time spend in the standing frame for those who were wheelchair confined as well as strength, endurance, and conditioning information. Due to the specific modification of the exercise program to each participant, full program comparisons between subjects could not be done.

Table 9

Strength and Endurance Exercise Program

Phase: I
Objective: Increase Overall Strength
Type of Equipment Used: Stationary Machines

Exercise	Focus
Leg Curl	Hamstrings
Back Row	Overall Back Area
Leg Extension	Quadriceps
Lateral Pulldown	Upper Back
Shoulder Press	Overall Shoulder Area
Chest Press	Overall Chest Area

Tricep Extension	Overall Tricep Area
Bicep Curl	Overall Bicep Area
Abdominal Crunch	Overall Abdominal Area
Back Extension	Lower Back

Phase: II
Objective: Strength, Balance and Coordination
Type of Equipment Use: Stationary Machines, Balance Equipment

Exercise	Focus
Back Row Tricep	Overall Back Area
Pushdown Rotator Cuff	Overall Tricep Area
Exercises Chest Press	Rotator Abduction/Adduction
Bicep Curl	Overall Chest Area Overall
Abdominal Crunch	Bicep Area Overall Abdominal
Back Extension/Superman	Area Lower Back
Balance on Balance Board	Side-side/Back -Front Balance
Swiss Ball Squats Wrists	Quadriceps/Balance Hand and
Curls	Finger Strength
Wrist and Forearm Strength	

Phase: III
Objective: Balance/Coordination and Strength
Type of Equipment Used: Free Weights, Balance Equipment

Exercise	Focus
Dumbbell Bench Press	Unilateral Chest Strength
Dumbbell Shoulder Raises	Front/Side/Back of Shoulder Area
Wrist Curls	Hand and Finger Strength
Wrist and Forearm Strength	
Abdominal Crunch Back	Overall Abdominal Area Lower
Extension/Superman	Back Side-Side/Front-Back
Balance on Balance Board	Balance Quadriceps/Balance
Swiss Ball Squats	
Hip Raises	Hip Abduction and Adduction

Data were analyzed by repeat measures and analysis of variables using Proc GLM in SAS to account for variability between subjects and within subjects due to repeated measures at baseline, 3 months and 6 months. Each treatments was blocked by disability class and weights modeled at each time point (Baseline, 3 months and 6 months). The assumption that improvement performance occurs in all classes of subjects despite levels of disability for each treatment was tested using Huynh-Feldt epsilon. Sphericity assumption was satisfied.

RESULTS

Characteristics of the Study Population

A total of sixty-seven subjects enrolled and completed the 6 month exercise program at Fast Forward Gym. Individuals were excluded if a total time of > 2 weeks were missed at any time during the 6 months of exercise or if attendance dropped below weekly participation. Participant's age range was 24-75 years of age with mean subject age of 49.5 years. There were 18 males and 49 females with a female bias of 2.7:1. MS is a predominately female disease with a 2:1 or 3:1 female to male ratio. Three subjects were black (4.7%) and 64 were Caucasian reflecting Nebraska's population prevalence of 4% blacks. Participants included relapsing/remitting MS (RRMS) patients as well as those considered secondary progressive. The range of EDSS scores was 1-8: 40% (n=27) had an EDSS of 1-4.5, 35% (n=23) had an EDSS of 5-7 and 25% (n=17) an EDSS of 7.5 or higher. Time since diagnosis ranged from 1 to 45 years, with 43 participants diagnosed 10 years or less.

MS treatment varied. Six (9%) were on no treatment, 33 (49%) were on Avonex, 6 (9%) were on Betaseron, 12 (18%) were on Copaxone, 6 (9%) were on Rebif and 4 (6%) were on Novantrone. There was no significant impact of treatment choice on exercise outcome. Only two individuals had an MS relapse during the exercise program and both responded to standard steroid therapy with a return to baseline status within 2 weeks.

Effects of Exercise

As expected, between subjects analysis demonstrated that individuals with Disability Level 1 (mildly disabled) start at a higher training weight or resistance level than those with Disability Level 2 (moderately disabled) and those with Disability Level 3 (severely disabled). They also continue throughout the program to perform at proportionally higher levels. Subjects with Disability Level 2, likewise, out perform subjects in Disability Level 3. This performance difference was maintained throughout each treatment.

Each within-treatment analysis was significant (Table 10). Each specific exercise showed significant improvement in the strength for participants, despite their disability levels. Increases in muscle strength followed parallel improvement pathways, reflected at all disability levels (Figures 4-15). All but one treatment displayed highly significant improvement over the exercise course with a p-value <0.0001. "Abdominal Crunches" had a p-value $=0.0142$ but remained significant at an $\alpha = 0.05$ level. This value, however, was recorded with only one participant in Disability Level 3 and should not be generalized to that population.

These findings support the hypothesis that a strength training program improves strength and endurance in subjects with MS, despite varying degrees of disability.

Table 10

Means By Time And Disability Group

	# of Patients	Baseline	3 months	6 months	P value
Leg Curls					
EDSS 1	9	19.444	26.666	31.666	< 0.0001
EDSS 2	5	14	19	23	
Back Rows					
EDSS 1	17	28.823	40.588	49.264	
EDSS 2	13	25	33.076	38.846	< 0.0001
EDSS 3	3	18.333	28.333	35	
Leg Extensions					
EDSS 1	15	22.333	29	34	
EDSS 2	14	16.071	20.892	24.464	< 0.0001
EDSS 3	3	14.166	17.5	21.666	
Lat Pulldown					
EDSS 1	16	21.718	29.687	34.062	
EDSS 2	14	16.25	23.214	28.035	< 0.0001
EDSS 3	2	15	22.5	25	
Shoulder Press					
EDSS 1	15	19	28.833	34.333	
EDSS 2	13	16.153	19.615	22.291	< 0.0001
EDSS 3	4	9.25	11.375	14.75	
Chest Press					
EDSS 1	16	26.875	32.812	39.062	
EDSS 2	13	18.653	23.461	26.923	< 0.0001
EDSS 3	2	15	22.5	27.5	
Tri Ext					
EDSS 1	14	25.714	32.321	37.8-5 7	
EDSS 2	14	19.285	24.107	28.214	< 0.0001
EDSS 3	1	20	25	30	
Arm Curl					
EDSS 1	16	21.406	27.812	32.031	
EDSS 2	13	15.038	19.038	22.346	< 0.0001
EDSS 3	8	5.75	8.375	12.75	
Ab Crunch					
EDSS 1	15	27.666	37.333	47	
EDSS 2	14	23.928	31.071	35.714	0.0142
EDSS 3	1	30	20	25	
Back extension					
EDSS 1	15	92	113.333	132	
EDSS 2	13	70.769	88.846	102.308	< 0.0001
EDSS 3	1	80	100	120	
Shoulder raises					
EDSS 1	14	4.642	5.857	6.535	
EDSS 2	14	3.285	4.035	4.535	< 0.0001
EDSS 3	7	2.428	3.571	4.5	
Wrist Curl					
EDSS 1	14	4.714	5.964	5.964	
EDSS 2	15	3.5	3.966	4.166	< 0.0001
EDSS 3	8	2.875	3.5	4	

Figure 4. Leg Curls and Figure 5. Back Rows

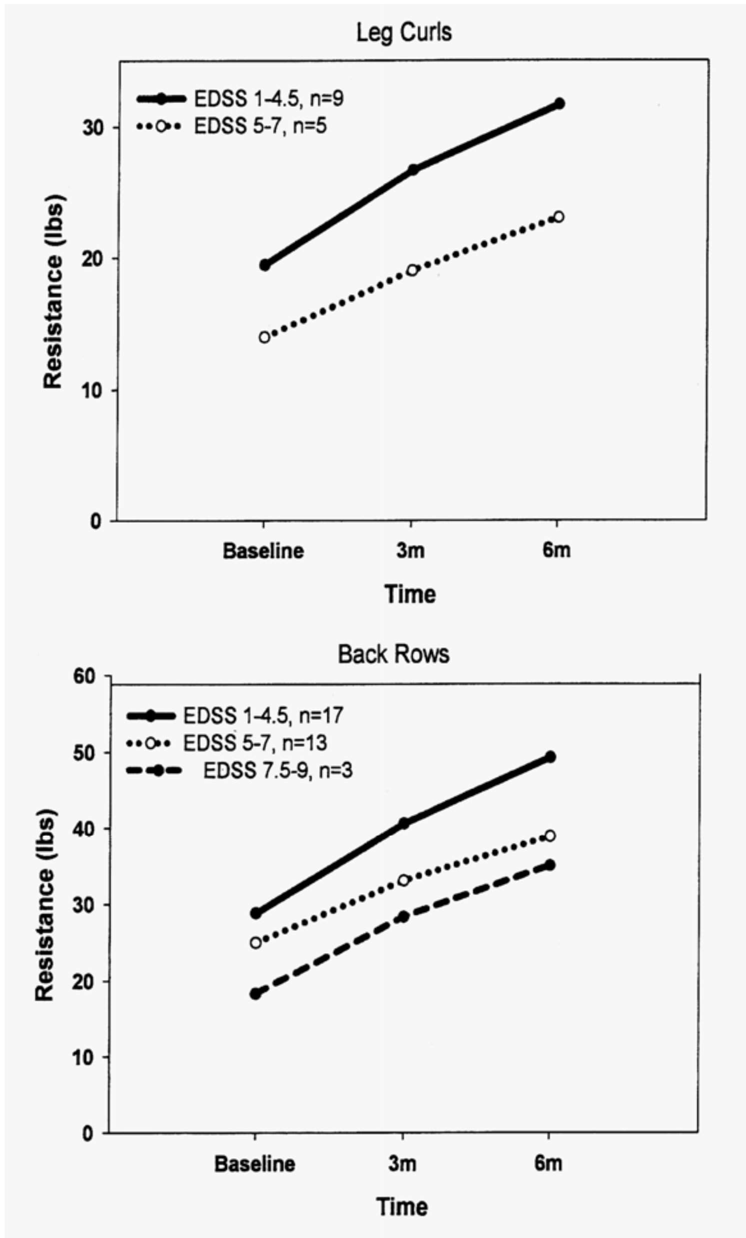


Figure 6. Leg Extentions and Figure 7. Lat Pulldowns

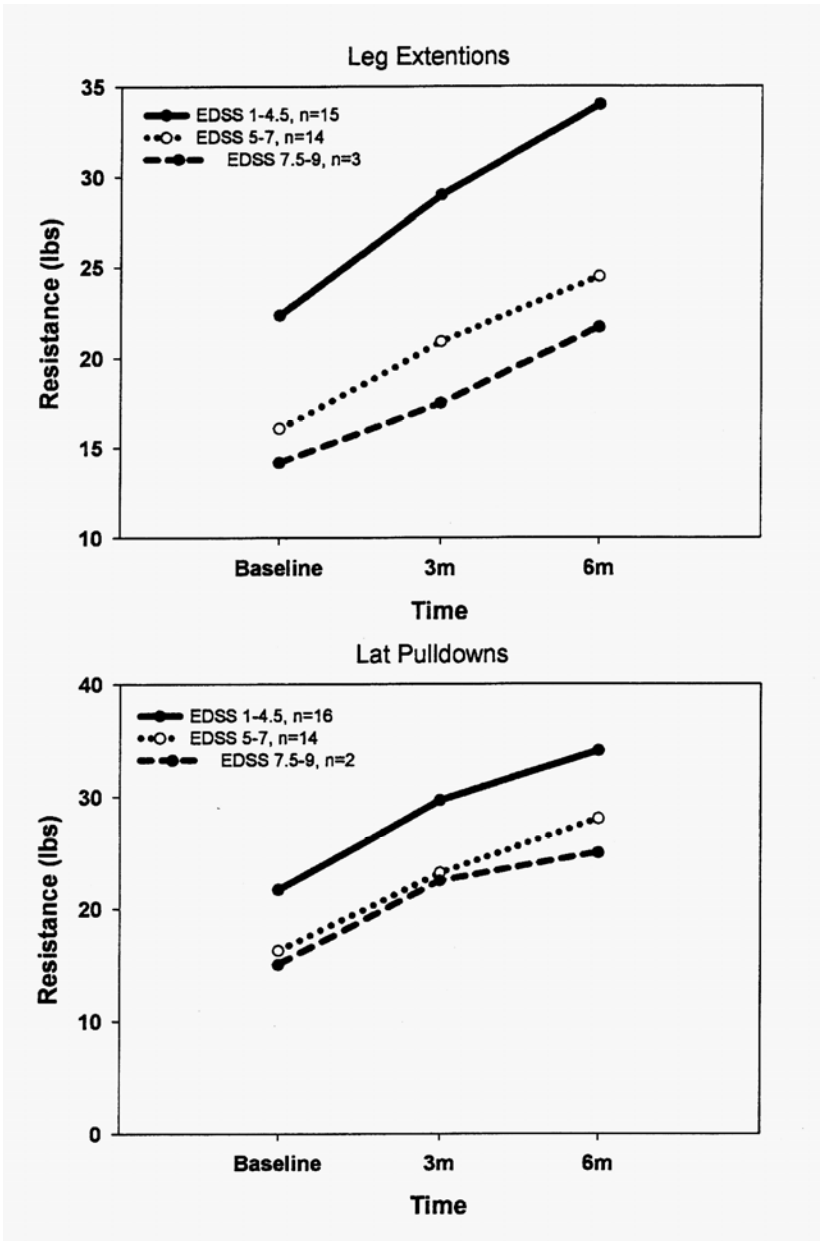


Figure 8. Shoulder Press and Figure 9. Chest Press

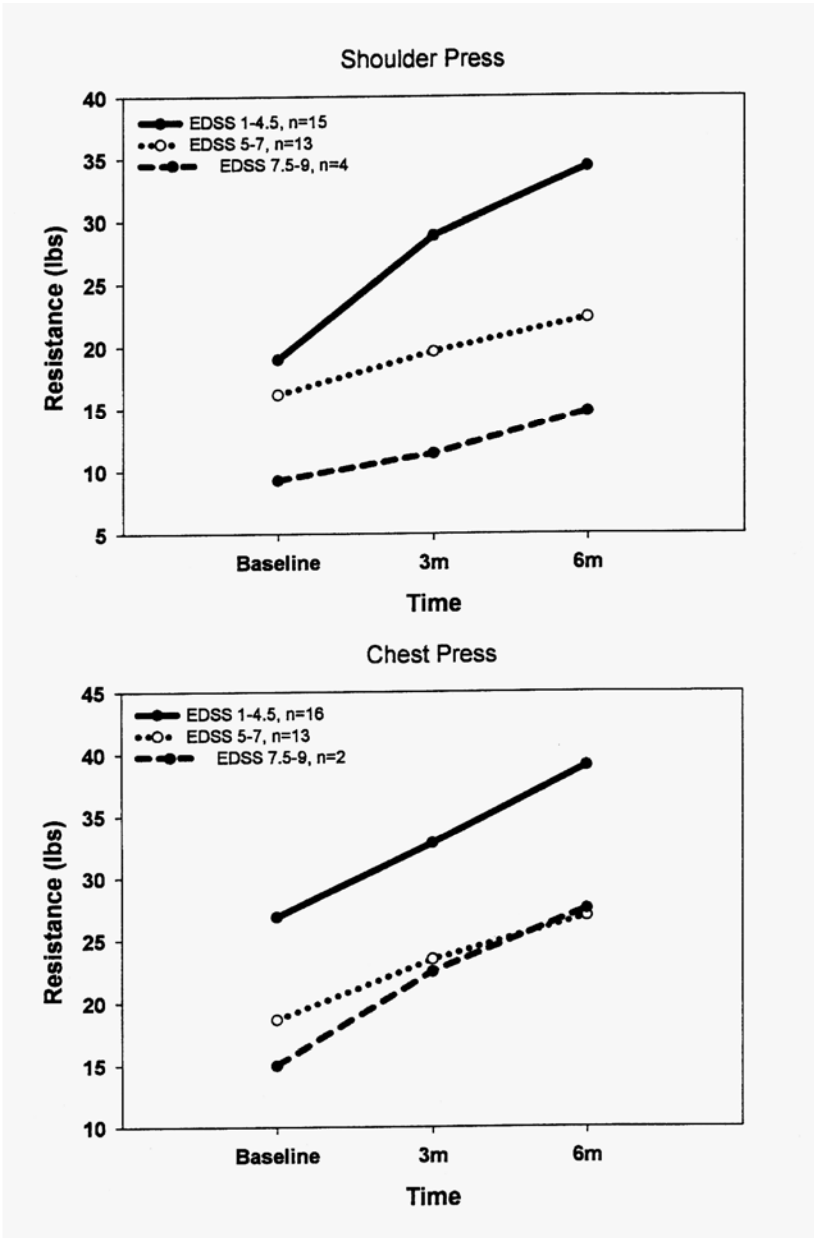
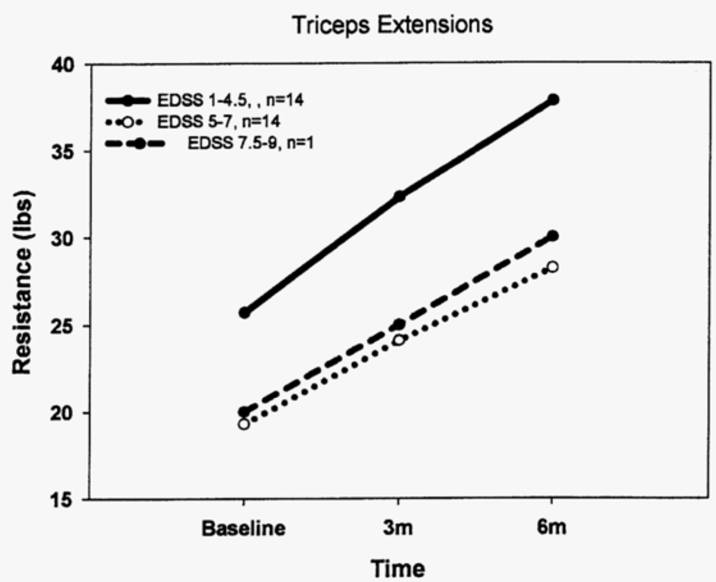


Figure 10. Triceps Extensions and Figure 11. Arm Curls



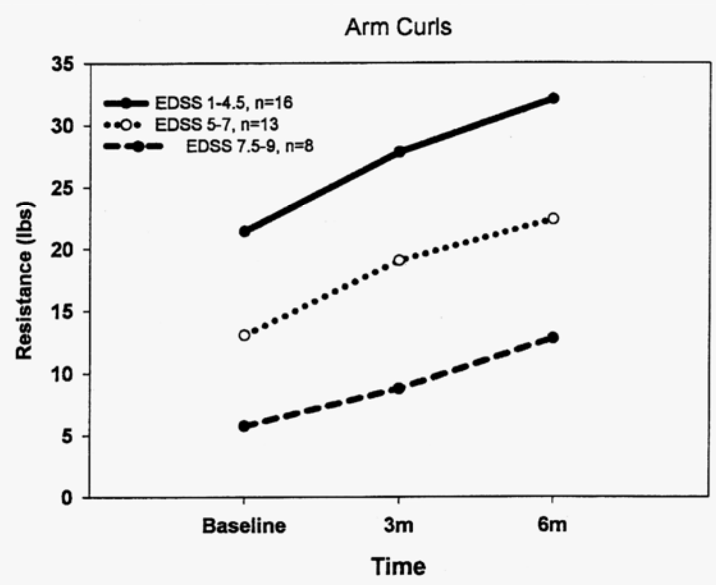


Figure 12. Ab Crunch and Figure 13. Back Extensions

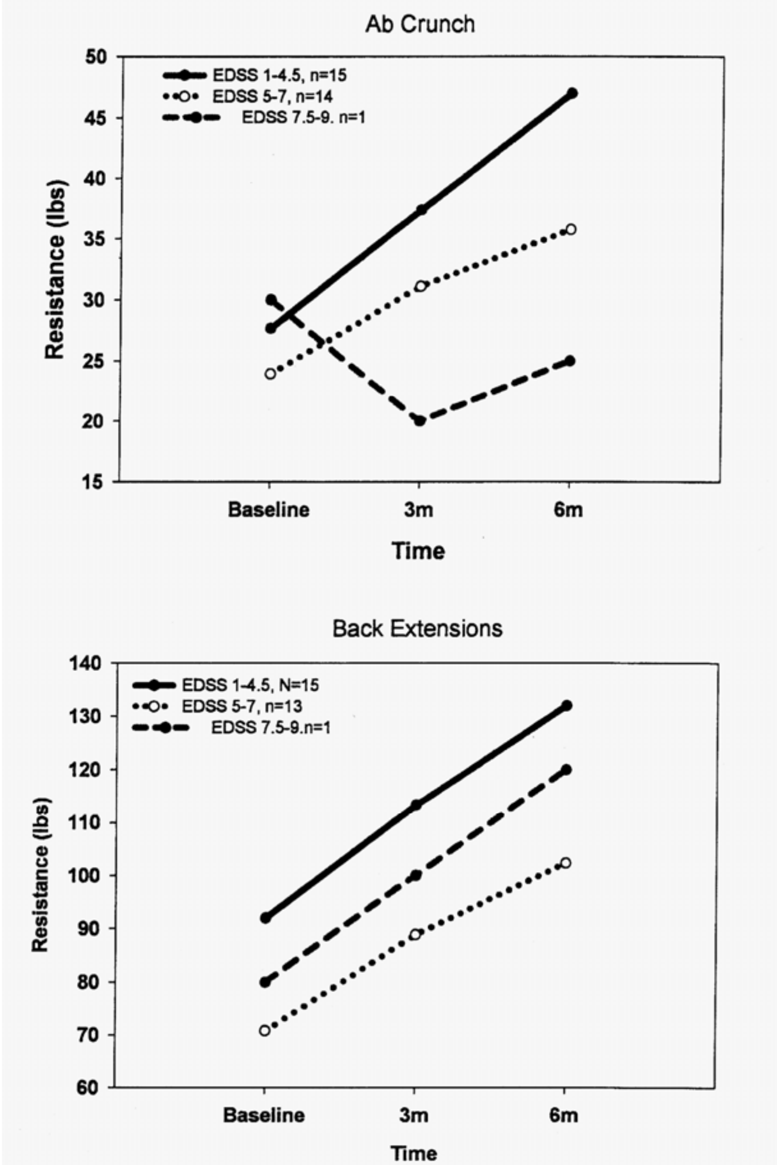
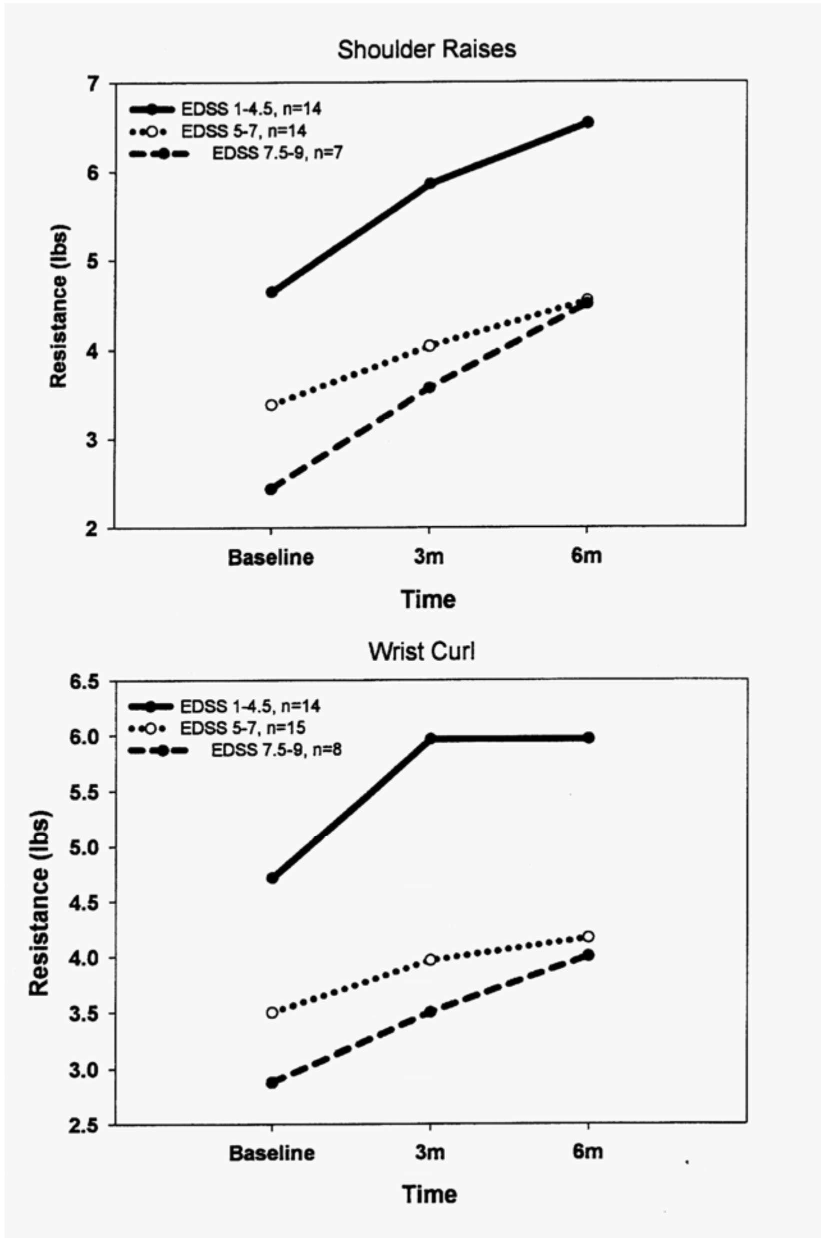


Figure X

Figure 14. Shoulder Raises and Figure 15. Wrist Curl



Discussion

Review of Effects of Exercise in Inflammation and MS:

Over the last ten years, pharmacologic treatments for RR-MS decreased the number of MS relapses and their severity in many MS patients. However, despite treatment, patients continue to report fatigue, muscle weakness, lack of endurance and balance problems due either directly to their MS or as a side effect of the immunotherapy treatment (Leuschen et al., 2004).

Several studies report that physical rehabilitation has a positive effect in MS patients (Solari et al., *1999;* Kileff & Ashburn, 2005; Rietberg et al., 2005; Romberg et al., 2004; Schulz et al, 2004; White et al., 2004). Other earlier studies evaluated inpatient rehabilitation programs (Freeman et al., *1997)* that are not routinely available or covered by insurance in this country. With the new treatments, more RR-MS patients maintain at low levels of disability and often remain in the work force. Many, however, report ongoing fatigue, muscle weakness and balance problems. Previous studies concentrated on maintaining or improving quality of life and disability outcome measures in RR-MS patients (Solari et al., *1999)* but did not evaluate traditional strength and endurance outcome measures.

The skeletal muscle of people with MS displaying moderate impairment and muscle weakness, have similar muscle fiber characteristics as age-matched sedentary control (Carroll et al., 2005). This supports the hypothesis that the quality of skeletal muscle is unaffected by MS, at least in the early stages of the disease. Lower lactate levels occur during training, despite higher workload levels indicating a training effect.

Disease-specific quality of life measures and coordinative parameters improve following low-level aerobic training in MS patients (Schulz et al., 2004)

Romberg, et al. (2004) report that individuals who maintain the ability to walk, with EDSS scores between l.0 - 5.5, could increase their walking speed following a progressive 6-month exercise program. Intervention consisted of strength and aerobic training initiated during a 3-week in-patient rehabilitation programs and continued for 23 weeks at home. Twenty two percent of the exercising MS patients show clinically meaningful improvements. White et al.(2004) as well as Kileff and Ashburn (2005), conclude that MS patients are capable of making positive adaptations to resistance training that are associated with improved ambulation and decreased fatigue.

Dynamic strength training combined with endurance type physical activity improves muscle strength and physical function in patients with early rheumatoid arthritis (Hakkinen et al., 2002), which shares many inflammatory features with MS. While exercise may be safe for MS patients and should be recommended for those with mild to moderate disability, no data are available for those individuals more disabled.

This study is unique because no previous study evaluated and showed improvement in individuals with MS who displayed Expanded Disability Status Scale (EDSS) scores of > 5.5. All previous study participants were able to ambulate with little or no assistance.

The effect of exercise programs on immune or inflammation markers in RR-MS patients is still unclear. Heesen et al., (2003) could not demonstrate a proinflammatory immune deviation in response to physical stress in MS patients. They show a hyporesponsiveness to induction of TNFα and IL10 in MS as compared to unaffected controls, indicating that exercise helped forestall or reduce inflammation in these individuals. All other markers were comparable to the control group. Heesen's work (Heesen et al., 2003) supports the hypothesis that individuals with MS, respond to exercise like normal healthy individuals. It suggests that exercise may decrease systemic inflammation. MS is a disease state marked by chronic inflammation particularly during the relapsing remitting state. Chronic, low-level elevation of Interleukin 6 (IL-6) occurs in MS as well as in many outwardly healthy elderly individuals. Elevated IL-6 may be a mechanism contributing to the development of muscle atrophy or wasting in the natural aging process by down regulation of growth factor-mediated intracellular signaling (Haddad et al, 2005). Exercise plays an integral part in reducing IL-6 and keeping aging muscles healthy (Jankord et al., 2004).

Exercise training reduces anti-inflammatory effects of certain chemokines. Troseid et al. (2004) report a significant reduction in monocyte chemoattractant protein-1 (MCP-1) and IL-8 in a 12-week exercise trial of patients with metabolic syndrome, a disease known for inflammatory characteristics, like MS. Gielen et al. (2003) note significant reduction of local expression of TNF-alpha, IL-1-beta, IL-6, and iNOS by up to 52% in the skeletal muscle of chronic heart failure (CHF) patients. Local anti-inflammatory effects of exercise were speculated to attenuate the catabolic wasting process associated with the progression of CHF in the study by Gielen's group.

The influence of regular physical activity, independent of disease and disability, on the levels of pro- and anti-inflammatory cytokines was examined in older (65-74 yr) males by Jankord and Jemiolo (2004). A higher volume of regular physical activity was associated with decreased IL-6 levels and increased IL-10 levels in these healthy older males. The study supports the hypothesis that exercise may play a vital role in modulating inflammatory markers during the aging process. In chronic kidney disease patients, resistance training reduces serum C-reactive protein (CRP) levels, 11-6 levels and increases muscle hypertrophy and muscle strength (Castaneda et al. 2004). Regular physical activity not only reduces inflammation but improves nutritional status in individuals with moderate chronic kidney disease consuming a low-protein diet. Proper nutrition is a concern in individuals with MS, due to the slowing of gut motility, changes in absorption and inadequate intake related to swallowing difficulties in many patients.

Outcome Measures specific to Exercise Physiology

The functional unit of the neuromuscular system, motor unit consists of the a motor neuron and the associated muscle fibers it activates. When maximal force is desired from a muscle, all the available motor units must be activated. Different types of motor unit firing rates or frequencies affect muscle force by an adaptive mechanism called the "size principle". This, in turn, is affected by resistance training. With resistance training, muscle fibers increase in size and muscle fibers are recruited in consecutive order by their size to produce high levels of force. The CNS may adapt, in trained individuals, by not recruiting some motor units in consecutive order but by recruiting larger units to help with a greater production of power or speed (NSCA, 2000). This type of adaptation is hypothesized to be the mechanism for how muscle strength training might help those with MS.

Practically, when starting a training program, a variety of alterations must take place to increase the strength, power and size of the muscles trained. The CNS, motor neurons and associated muscle tissue are the primary physiological systems involved with the needed adaptations for increased force production. High intensity (5Rm and lower) and low-volume multi-joint lift training programs primarily affect neural factors (e.g., recruitment patterns, activation, and inhibition). Resistance training normally increases performance by increasing muscle strength, muscle endurance, aerobic power, maximal rate of force production, muscle fiber size, capillary density, mitochondrial density and subtype conversion to Type II muscle fiber (NSCA, 2000).

The neuromuscular junction (NMJ) is a major site of plasticity. While data describing the molecular mechanisms involved with neural adaptation to general exercise training are limited, it is hypothesized that heavy resistance exercise training produces morphological changes in the NMJ. Changes related to heavy resistance exercise training are of a greater magnitude than adaptations to low-intensity aerobics. During progressive overload in resistance training, neural factors may mediate greater strength increases without large increases in cross-sectional muscle area. In healthy individuals, increases in muscle strength from pre-training values can range from 7% to 45%: the increase for a given person depends largely on the starting level of strength (NSCA, 2000). It is hypothesized that the use of resistance exercise training will produce a similar increased muscle strength and endurance in MS patients, independent of disability level.

Significance of the present study

Individuals with MS, regardless of the degree of disability or EDSS scores, benefit from an individualized exercise program of endurance and strength training in select areas of performance. Data from within subjects trials at 3 time points (baseline, 3 months and 6 months) show strength improvement on similar trajectories independent of established disability levels in all but one treatment, that of abdominal crunches. This data support the hypothesis that individuals with MS benefit from strength and endurance training, demonstrating that muscles of those with MS respond to training intervention much like unaffected individuals. Initial increases in strength and endurance are greater in those subjects who are more deconditioned but improvements are significant in all groups. Any training advantage disappears as conditioning continues.

Clinical observations of moderate to severely disabled MS patients describe a decline in core strength with subsequent loss of balance related to this muscle weakness. Weakness is most easily observed in the hip flexors, but is also significant in the abdominal muscles. It is reasonable to predict that the exercise area least likely to show improvement in the severely disabled would involve these particular muscles. Subjects with mild to moderate disability show a normal treatment curve as compared to other exercise areas.

Interventions for individuals with MS, by health care providers, are generally limited to brief interactions with physical therapy and occupational therapy programs, particularly if disability is moderate to severe. The driving force for being able to remain in these programs are maximum or continued improvement after an acute event, not maintenance of function during a chronic process. Individuals are "counseled to leave the program" or payment is denied when maximum improvement is reached. The difference in utilizing physical therapy for a condition like MS rather than an acute disability is that maintenance of abilities is the primary outcome. Disease advancement and subsequent disability is integrally related to the natural progressive nature of the disease. Many programs also are not incorporated into the life styles as practiced health habits. The exceptions are specific individuals who have intense personal goals and persistence and are capable of carrying out the exercise program by themselves in an atmosphere of isolation. Unfortunately, few people are that driven and most need a defined program, facility, exercise group or personal trainer to carry out a routine exercise program.

Exercise has long been felt to be the cornerstone of a long and healthy life style. However, as people age or accumulate disability the idea of extending regular exercise diminishes for no apparent reason other than it becomes increasingly difficult to facilitate. Research is limited and has looked at only those individuals who can walk with minimal assistance. Most healthcare providers switch recommendations from conditioning exercise to stretching exercise only. Expectations drop dramatically for an individual who is wheelchair confined. These individuals are viewed as a disabled individual instead of an individual with disabilities.

Individuals with chronic illnesses make up a large portion of our population today. They enter the health care arena at time of diagnosis and on occasion are sent to physical therapy or rehabilitation during the acute phase of illness. The insurance coverage for these services falls off quickly after an acute episode. Individuals are often left to their own resources in regards to how to proceed with exercise or physical therapy. There is an assumption no further actions are needed by the health care community. The impact of exercise on the quality of life for someone with a chronic illness can be as important as that for the healthy and should automatically be addressed at each health care visit.

Most private exercise facilities cater to the young and healthy but do not allow for those individuals that need time and attention to complete exercise programs, even if those individuals may be the ones that would benefit the most. They clog the system and do not allow for fast turnover of equipment or space. One of the most common complaints among the disabled is that they do not feel welcome in the new age, high tech exercise arena.

The role of inflammation in MS is poorly understood. There are two separate disease phases that present in most individuals with MS. The highly inflammatory phase presents itself early. After approximately 10-15 years, the disease turns to a secondary less inflammatory phase. How exercise might affect either phase has been evaluated only peripherally. It was noted that only 2 individuals suffered relapse during the research period. Both were treated with 3 days of IV steroids and both returned to pre-relapse performance levels within 2 week. It is not known if this rapid return to baseline is related to the exercise intervention.

During a relapse, areas of axons are damaged or destroyed during the inflammatory process. It is speculated that nerve rootlets are present for a limited time at the site of injury and can possibly be stimulated to grow; replacing the destroyed fibers. establishing new collateral impulse pathways. If this is the case, the use of significant, regimented exercise to stimulated growth and subsequent use of these pathways would decrease the degree and extent of permanent injury. It would be comparable to building collateral circulation to the cardiac muscles following a myocardial infarct. It would suggest that the immediate decrease of inflammation followed by aggressive physical therapy or exercise training would positively impact final outcome of these flairs and decrease further disability. No research in this area has been done.

Rietberg et al. (2005), review nine high-methodological, quality, randomized controlled trials dealing with exercise and MS. Best evidence synthesis showed strong evidence in favor of exercise therapy compared to no exercise in terms of muscle power function, exercise tolerance functions and mobility-related activities. Moderate evidence was found for improving mood. In these studies, no evidence was observed or primarily monitored for exercise related benefit on fatigue and perception of handicap. No specific exercise therapy programs were shown to be more successful in improving activities and participation than other exercise treatments. No evidence of deleterious effects of exercise therapy was described in the included studies.

This particular exercise protocol was initiated in 6 individuals to provide preliminary data to guide treatment protocols. Numbers of participants rapidly grew due to the significant improvement that was verbally reported by those participating in the exercise program. Data were available due to standard record keeping of program progression at Fast Forward Gym combined with information from clinical notes at UNMC MS Clinic. A prospective study should be initiated to look at the role of inflammatory cytokine markers during this type of exercise program along with parameters to measure disease relapse numbers and severity of symptoms. Levels of IL-6, sialic acid and CRP may indicate smoldering CNS inflammation and the degree of muscle atrophy or wasting that will take place. Fluctuating, inflammatory cytokine levels may indicate the state of disease activity. Due to anecdotal reported improvements in fatigue levels, fatigue measures should also be noted to determine what type of measurable impact exercise plays on MS individuals.

Further studies should be designed to include assessments of quality of life indicators as compared to parameters of strength and conditioning improvements. Consideration should be given to include depression screenings both pre and post training to quantify changes in their perceptions. Training sessions have given participants a feeling of self-worth and fulfillment by verbal report and have been referred to as a type of proactive support group for those involved.

Since many research studies have excluded those individuals who have reached wheelchair dependency as being too disabled or difficult to observe for changes, it becomes imperative that all levels of disability be considered. Disabled individuals deserve to be included in research that can significantly impact their quality of life. Causing any positive change in their condition even minimally, may affect them considerably more than those less disabled.

SUMMARY

Regular resistance exercise programs show benefit in individuals with MS despite varying levels of disability. A parallel response curve is seen despite level of disability and lower weight resistance thresholds. Exercise may go beyond cardiac and strength benefits and impacts the disease itself by alterations of inflammatory cytokines. Individuals participating in a regular exercise routine appear to have a shorter recovery time from MS flairs, returning to pre-relapse activity more quickly. It is not known if the use of regular exercise reduces the frequency of MS attacks. The routine use of weight resistance exercises as an adjunct treatment in the fight against MS should be considered.