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People with Multiple Sclerosis (MS) Improve in Measures of Health and Function after Participation in a Community-based Exercise Program

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Abstract

Objective: Exercise is safe for people with Multiple Sclerosis (MS) and is necessary to combat the secondary deconditioning resulting from MS-related weakness and fatigue. People with MS often encounter barriers to exercise, such as inaccessible facilities/equipment, lack of proper guidance, and limited finances. This study examined outcomes in nine people with MS who participated in an outpatient exercise program designed specifically for people with MS.

Design: The program was designed in part based on input from a focus group of participants with MS. Group exercise and education classes were coordinated by a physical therapist and an exercise specialist. Specific exercises were chosen for each individual based on their impairments and ability. Outcome measures collected before, and 3 and 6 months after, program initiation assessed cardiorespiratory function, weight and body mass index, metabolic function, functional strength and quality of life.

Results: Participants demonstrated improvements to varying degrees in all outcomes.

Conclusions: A semi-individualized, group exercise program may provide people with MS an alternative feasible and viable method for exercising in an outpatient setting. Further research is necessary to determine the combination of exercise and educational variables that will lead to the most efficacious outcomes for any given individual with MS.

Keywords: Exercise; Fitness; Multiple sclerosis; Wellness

Introduction

The phrase "exercise is medicine" has recently come to the forefront of the exercise physiology field, in recognition of the fact that exercise can ameliorate or reverse many of the most common causes of disease and disability [1,2]. Although current evidence suggests that regular exercise for people with Multiple Sclerosis (MS) is safe, [3-8] there remain several barriers to exercise participation. Symptoms of MS, as well as external barriers, such as inaccessible gyms or equipment, lack of knowledge about how to safely exercise with MS, lack of understanding about the types of exercise that would be beneficial, and financial concerns may all negatively impact their ability or desire to participate in exercise [9-13]. In order to promote exercise and activity in people with MS, these disease-specific barriers must be broken down.

Many studies have quantified the positive effects of exercise, but people with MS tend to engage in physical activity at a level well below that of the general population [14-16]. The concern that exercise aggravates MS symptoms has been diminished in part by studies that demonstrate that exercise can decrease fatigue [17-20], pain [21], spasticity [22] and even cognitive deficits [18,23] and depression [24]. Yet people with MS continue to report barriers to participation in exercise [10]. The working hypothesis for this study is that by eliminating, or at least decreasing, these barriers, people with MS will exercise, and will receive health and functional benefits from this exercise.

The purpose of this paper is to present the perception of barriers and facilitators to exercise in members of an MS community, and to describe a program and related outcomes based on the information gained from this group.

Methods

Overview

A team comprised of two researchers, a physical therapy manager, and an exercise physiologist hosted a focus group to discuss the exercise and wellness needs of people with MS in the local community, and the barriers they perceived to their participation in exercise. The focus group was conducted as an in-person, directive and structured discussion session led by a researcher trained in focus group moderation and a researcher with expertise in MS. Interview questions were defined prior to the meeting, and were reviewed and edited by the MS researcher, the moderator researcher, and the MS clinical manager and exercise physiologist in the MS clinical program. Questions focused on identifying specific barriers to exercise that had tangible solutions, as well as addressing subjective reasons for engaging in or avoiding exercise. Participants for the focus group were identified by the clinical team based on their availability to participate. The focus group was convened and the researchers posed the questions to the group and led the discussion.

A physical therapist and exercise physiologist then designed a program tailored to respond to the needs identified by the focus group participants. The program was specifically designed to ameliorate barriers to exercise, and combined theories of physical therapy, exercise science, and nutrition. The resulting health and wellness program was based in an outpatient department in a private, non-profit rehabilitation facility, and was open to the MS community.

Intervention

All classes for the health and wellness program were offered in a group setting. The exercise classes addressed core and lower extremity strengthening, and cardiovascular conditioning. Clients could elect to take one, two or three of the classes each week. Designed to isolate certain muscle groups, each class allowed clients to receive a personally tailored workout. All exercise classes were 60 minutes in duration and were instructed by an exercise physiologist with knowledge and experience in MS. One therapy technician provided assistance as necessary to guide exercise or provide support. Each class consisted of people with different MS subtypes.

The Core Strengthening class focused on strengthening the major muscle groups of the core, e.g., rectus abdominis, external obliques, and the paraspinal muscles. Examples of exercises for the core class include abdominal crunches, planks, side crunches, and lumbar rotations using a large Swiss exercise ball. The core class used an instructor to client ratio of 1:7.

The Cardiovascular class was intended to provide the client with a beneficial and safe cardiovascular workout. This was accomplished by increasing the client's heart rate to their target heart rate range, or as close to it as possible, under the guidelines of the American College of Sports Medicine [25]. A circuit-rotation structure was used to move clients around to each “station” which included: boxing, Nintendo Wii, tubing, cycling, and ropes. This class had an instructor-to-client ratio of 1:5. Traditional and non-traditional exercise methods were used. Upper and lower extremity cycling are examples of traditional exercises used in the class while boxing, and fitness training ropes are examples of non-traditional cardio exercises.

The Lower Extremity Strengthening class focused on strengthening and conditioning of the major leg muscles. Squats, leg extensions, and bridging were used to strengthen the rectus femoris and gluteus maximus muscles. Other exercises used for strengthening included side-lying hip abduction for the gluteus medius, hip hiking for hip flexors, and calf raises in standing targeting the gastrocnemius and soleus. The lower extremity class had a ratio of 1:7 to allow for attention to quality of the exercises performed.

In addition to the exercise classes, clients could participate in education classes addressing other areas of wellness for people with MS (Table 1). A meditation class was offered once a week. Led by a psychologist certified in stress management, the clients were guided through a number of stretching, breathing, and relaxation exercises. The maximum number of participants for this class was ten. The skills-based social group was designed to offer clients a place to socialize and fellowship. One area of focus involved sharpening fine-motor function and hand-eye coordination by playing board games. Clients also played card games to practice cognitive functioning and task performance. There was no limit on group size for this class.

Lecture Topic	Profession of Speaker
Energy Conservation/Managing Fatigue	Occupational Therapist/Nurse Practitioner
Managing Your Healthcare Team	Case Manager
Trustworthy Resources	Librarian
Therapeutic Recreation	Recreation Therapist
“Can I work again?” - Vocational Rehab	Vocational Rehab Specialist
MS and Nutrition	Registered Dietician
Stress Management	Psychologist
“On The Horizon” - New Therapies	Doctor
Adapted Yoga	Certified Yoga Instructor
Medication Management	Nurse Practitioner
MS Research Update	Research Director
Bowel and Bladder	Nurse Practitioner
Pain and Spasticity	Physician's Assistant
Cognitive Dysfunction	Nurse Practitioner
MS Relapses	Physician's Assistant
Massage	Licensed Massage Therapist
Aquatics	Aquatics Specialist
Acupuncture for MS	Licensed Acupuncturist
Exercise Benefits For MS	Exercise Physiologist
Financial Wellness	National Disability Institute - Webinar
Sleep Disorders and MS	Psychologist
“Getting Organized”	Speech Tfherapist
Pilates	Certified Pilates Instructor

Table 1: Lecture series topics and speakers.

Program funding was supported by membership fees paid by program members or by subsidized membership through the local chapter of the National Multiple Sclerosis Society. Existing equipment and space in the rehabilitation gym was used for classes with the exception of a Theraband station (cost of $45). Membership fees covered 85% and donated funds covered 15% of the exercise physiologist salary.

Data Collection

Focus group

Data for the focus group was collected via notes taken by the researchers at the time of the focus group session, and was also collected offline after completion of the focus group session. The session was recorded, and transcribed, then vetted by the principal investigator and one other clinical investigator to identify major themes in the responses to the questions.

Health and Wellness program

Approval for the collection of outcome measures to obtain pilot data related to the health and wellness program was granted through the Research Review Committee at the institution.

Clinical measures were collected before initiation of the program and 6 months later. Measures included cardiac function (heart rate, blood pressure), body mass weight and index, respiratory and metabolic function (metabolic cart), functional strength (pull ups and pushups), walking, and quality of life (MS Quality of Life Inventory; MS-QLI) [26]. All outcome measures were collected by a trained exercise specialist, except for the MSQLI, which was completed by the participant and returned to the exercise specialist upon completion.

Heart rate and blood pressure were measured primarily using the Dynamap V100 automatic pressure cuff (GE Medical, Freiburg, Germany). For ambulatory participants, body weight was measured using a standard "step-on" digital scale (Omron Healthcare, Inc., HBF-514, Bannockburn, IL). Body weight for non-ambulatory participants was measured using a large "roll-on" digital scale (Health Weigh by Rice Lake Weighing Systems, H340-10-3, Israel), subtracting the weight of the wheelchair from the total weight.

Percent body fat was measured using the US Navy standard algorithm in which circumferences were measured at the hips (for females), waist and neck. Those values were then input into the following equations:

Formula for men:

495/(1.0324-0.19077(LOG(waist-neck))
+0.15456(LOG(height)))-450

Formula for women:

495/(1.29579-0.35004(LOG(waist+hip-neck))
+0.22100(LOG(height)))-450

Resting respiratory and metabolic function was assessed using an Oxycon Mobile metabolic cart (CareFusion, San Diego, CA). Participants were placed in a supine position on a mat table and asked to completely relax but remain awake. Participants donned a face mask for 30 mins while resting metabolic rate and oxygen uptake (VO_2) were collected.

Hand strength was assessed bilaterally using a JAMAR Hydraulic Hand Dynamometer (Sammons Preston Rolyan, Bolingbrook, IL) [27,28]. While seated in a supported position, the participant was asked to hold the dynamometer, with the shoulder by their side, the elbow bent to 90 degrees, and squeeze at their maximal ability one time. Each hand was measured three times with a 30 second break in between each assessment and the three outcomes were averaged.

Abdominal strength was measured using an abdominal crunch test. Participants were supine on a mat table, and asked to complete as many abdominal crunches as they could in one minute. In order for an abdominal crunch to be counted, participants were instructed to crunch up until the shoulder blades made it completely off the mat. Once a participant was unable to move the shoulder blades off the mat, the test was stopped and the number completed to that point was recorded.

A modified pull-up test was used to measure upper extremity strength and endurance. Participants started in a supine position and reached up to grab a bar and pulled themselves up until their arms reached 90 degrees of elbow flexion. They performed as many as they could until they reached exhaustion. In this test, exhaustion was defined either to be the participant's inability to complete the full motion, or by the participant themself stating they needed to stop the activity.

Leg strength was measured using a one-repetition maximum (1RM) leg press test. Participants were tested to determine the maximum weight they were able to push just one time using a seated leg press machine (Leg Press, Cybex, Owatonna, MN). The weight on the leg press was started at 250 lbs, and then adjusted lower or higher until the participant is able to complete the 1RM.

Gait assessments included the 6 minute walk test [29,30] and the 10 meter walk [31]. Agility and balance during walking were assessed using the Timed Up and Go test [32]. Participants completed these tests wearing a gait belt around the waist for added safety and were monitored by only one clinician. The clinician's responsibility was to guard the participant and record the time to completion of each test.

The participant's perception of their quality of life was measured using the MS-QLI.26 This a MS-specific health-related quality of life instrument consists of the Health Status Questionnaire (SF-36), supplemented by nine symptom-specific to measures of fatigue, pain, bladder function, bowel function, emotional status, perceived cognitive function, visual function, sexual satisfaction, and social relationships, was completed by the participant. Upon completion the questionnaire was returned to the exercise specialist.

Data Analysis

Focus group

Data obtained from the focus group data was organized based on identifying the barriers to exercise for people with MS. The analysis was qualitative. The MS researcher organized and subdivided the transcribed notes based on themes related to exercise barriers, and searched for patterns within the subdivisions. A clinical investigator reviewed the data to ensure that all themes were identified.

Health and Wellness program

All data related to the outcomes measures for the health and wellness program were entered into a database, and analysis was carried out using means and ranges to describe the outcomes. T-tests of pre- and post-measures were performed to determine statistical significance for each outcome measure.

Effect size indicates the standardized difference between two dependent means and expresses this relationship in standard deviation units. Effect size was determined utilizing Cohen's d formula for dependent, single group, pre-post change. The formula takes the difference between pre and post means for the group, and then divides the difference by the baseline variance. Baseline variance is the standard deviation for the first time period (pre) of measurement [32]. Effect size (Cohen's d) for dependent means differences (matched pairs t-tests) is calculated by the equation:

Cohen's d=Paired Differences Mean/Baseline Standard Deviation

Results

Focus group results

Nine individuals with MS (6 female, 3 male), mean age 51 (38-69) participated in the focus group session. Focus group participant demographics are presented in Table 2.

Participant #	Sex	Year of Dx	Age at Dx	Current Age	Type of MS
F1	F	1998	43	59	RR
F2	F	2011	61	64	RR
F3	M	1993	36	55	PP
F4	F	2011	57	60	SP
F5	M	2008	37	43	PP
F6	M	1995	43	62	PP
F7	F	2006	24	32	RR
F8	F	2009	61	66	RR
F9	F	2000	39	55	RR
RR: Relapse remitting; PP: primary progressive; F: indicates participant in focus group, which may not correspond with Wellness study participants (i.e. Tables 5-7); Dx: Diagnosis					

Table 2: Focus group participant demographics.

Barriers	No. of participants indicating barrier (n=9)
Fatigue	7
Cost	5
Transportation	4
Effort (starting or continuing)	3
Availability of preferred exercise machines in gym	3
Don't like to exercise	2
Time	2
Need for assistance	2
Distance to travel to facility	2
Distance to from parking to location for exercise	2
Exercise is boring	1
Pain	1
Too repetitive	1
Uncertainty regarding what to do	1
Uncertainty about potential results	1

Table 3: Barriers to exercise participation identified by focus group participants.

Facilitators	No. of participants identifying facilitator (n=9)
Knowledgeable coordinator	7
Encouragement	5
If exercise alleviates symptoms	5
Seeing tangible results Weight loss Increased flexibility	4 1 1
Feeling better	4
Community working out with	4
If it's fulfilling	3
Knowledge of benefits	3
Wanting to fight MS	3
Making/having an appointment	1
Not feeling disabled	1
Scheduling transportation	1

Table 4: Facilitators to exercise identified by focus group participants.

Participants identified a number of barriers that prevented them from participating in regular exercise (Table 3), and the facilitators that would help them participate (Table 4). Although some participants indicated they would prefer to exercise at home, the majority identified the need for guided exercise groups with leaders educated in MS, as well as educational classes in symptom management, stress management and complementary/alternative options for treatment. Several participants (n=5) requested Saturday morning exercise classes. One person requested cognitive exercises. Three participants indicated they would like to be informed of reaching milestones or receive rewards for reaching those milestones.

Wellness study results

There were 88 clients enrolled in the health and wellness program, and specifically 48 were enrolled in the exercise classes. Data for the first 9 clients in the health and wellness program was analyzed. These clients agreed to participate in the collection of additional clinical outcome measures. Participant characteristics are presented in Table 5. The majority of participants were female (n=6), the mean age was 51.22 (range 38-69), and the mean time since diagnosis was 15.78 (range 3-30). All but one participant had a diagnosis of relapse-remitting MS, and this participant had a diagnosis of primary progressive MS. The average attendance rate across the group was 71% (range 62-84%). Typical reasons for missing were transportation difficulties, fatigue pertaining to MS (lassitude), lack of confidence, failure to remember appointments (cognitive dysfunction), and report of lack of motivation.

Participant #	Sex	Approx time since Dx (years)	Current Age (years)	Type of MS	Classes	Attendance Rate (%)
1	F	11	41	RR	Cardio Core	84
2	F	18	54	RR	Cardio Core LE Meditation	69
3	F	7	57	RR	Cardio Core	70
4	F	14	38	RR	Core LE	62
5	M	30	69	PP	Cardio Core LE	73
6	M	21	50	RR	Core Balance	69
7	F	12	42	RR	Balance Core	62
8	F	3	52	RR	LE Balance	66
9	M	26	58	RR	Core	84
Mean (range)		15.78 (3-30)	51.22 (38-69)			71 (62-84)
SD		8.80	9.81			8
Dx: Diagnosis; RR: Relapse Remitting; PP: Primary Progressive; SD: Standard deviation; LE: lower extremity						

Table 5: Wellness study participant demographics.

Table 6 presents health-related outcomes. Although there was not a significant decrease in body weight or total body fat, there was a statistically significant decrease in the average percent body fat at the hip and neck (p=0.02 and 0.04, respectively), with a small effect size for both (Cohen's d=-0.30 and -0.23, respectively). Metabolic rate, VO_2 max and resting heart rate did not change (p=0.32, 0.33, 0.87, respectively), in the group.

Outcome	Pre Ave (SD)	Post Ave (SD)	% Change	Ave% change	P value	Cohen's d
Weight (lbs)	162.00 (28.22)	162.96 (27.62)	0.59	0.67	0.61	0.03

Total %BF	33.35 (14.64)	31.40 (12.28)	-5.86	-1.04	0.12	-0.13
%BF waist	35.39 (4.44)	34.53 (3.12)	-2.43	-2.08	0.15	-0.19
%BF hips	41.56 (3.76)	40.44 (3.66)	-2.67	-2.65	0.02	-0.30
%BF naval	38.67 (6.81)	35.92 (4.40)	-7.11	-6.20	0.06	-0.40
%BF neck	14.06 (1.42)	13.72 (1.16)	-2.37	-2.37	0.04	-0.23
Metabolic rate	1511.78 (230.22)	1600.89 (301.16)	5.89	6.43	0.32	0.39
VO_2 max	2.87 (0.39)	3.02 (0.58)	5.19	5.36	0.33	0.38
Resting HR	77.56 (12.80)	78.44 (10.67)	1.15	3.09	0.87	0.07
BF: Body fat; BMI: Body Mass Index; SD: Standard deviation; % Change represents the change in group averages pre and post; Ave % Change represents the average change for each individual from pre- to post-test.						

Table 6: Health-related Outcomes (N=9).

Functional data are presented in Table 7. There was a significant increase (p=0.03) of a moderate magnitude (Cohen's d=0.56) in the number of abdominal crunches performed, as well as a significant increase in distance walked during the 6 minute walk test (p=0.04). The effect size for this change in distance was small (Cohen's d=0.27). Although there were minimal improvements in the other measures, these were not statistically significant.

Outcome	Pre Ave (SD)	Post Ave (SD)	% Change	Ave% change	P value	Cohen's d
Left Hand Strength (Dynamometer)	55.67 (18.40)	59.74 (10.67)	7.33	19.70	0.34	0.22
Right Hand Strength (Dynamometer)	57.67 (15.88)	60.59 (10.35)	5.07	13.98	0.44	0.18
Abdominal Crunch (#)	26.56 (15.78)	35.44 (19.96)	33.47	53.67	0.03	0.56
Pull Up Test (#)	15.33 (8.34)	16.67 (7.92)	8.70	32.10	0.55	0.16
1RM Leg Press (lbs)	123.33 (44.44)	132.22 (47.90)	7.21	8.03	0.12	0.20
6 Min Walk Test (feet)	11501.71 (5858.74)	13111.29 (6308.87)	13.39	16.83	0.04	0.27
10 m Test (secs)	15.63 (12.88)	11.74 (5.56)	-24.89	-12.54	0.23	-0.30
TUG (secs)	16.55 (7.71)	18.69 (13.00)	-12.91	-5.72	0.38	0.28
SD: Standard deviation; % Change represents the change in group averages pre and post; Ave % Change represents the average change for each individual from pre- to post-test.						

Table 7: Strength/Functional Outcomes (N=9, except 6 Min Walk Test N=7).

Discussion

There is a growing body of evidence suggesting that exercise is not only safe for people with MS but necessary to combat some of the consequences of MS. Yet people with MS remain relatively inactive [14,16]. Several barriers to exercise likely contribute to the sedentary lifestyle of people with MS. The findings from the focus group were in accordance with those reported by Asano et al. [9] who found that the top barrier to exercise is fatigue. Other barriers identified in their study were the same as those identified by the focus group participants for this study, albeit in a different order of importance. Based on this information, a combined exercise and education program was developed, and instituted in an accessible fashion for people with any type (relapsing-remitting or progressive) of MS, at any level of disability. The number of enrolled clients and the relatively high adherence rate (71%) demonstrate the benefit of incorporating insights from people with MS about their exercise and wellness needs.

Outcomes collected from this program indicate a positive effect of exercise on health and wellness. Study findings demonstrate that people with MS can achieve health-related and functional improvements after exercising regularly in a guided group exercise program. In many exercise studies to date, the participant is encouraged to work to a level that is "somewhat hard", [34-36] or to 50-70% of their max VO_2 [34]. No attempt was made to monitor exercise intensity, and for some participants, the intensity was somewhat less than what is reported in other studies. Yet, participants achieved meaningful outcomes even with this lower intensity of exercise. They also demonstrated good attendance and low drop out, suggesting that this level of exercise may be achievable in individuals with chronic disability due to MS.

There was a significant change in percent body fat at the neck and hips, and a trend toward a decrease at the naval, but the waist to hip ratio was not decreased in the participants in this study. Amount and location of body fat are important variables when considering ones risk of co-morbidity, such as cardiovascular disease [37]. People with MS are already at risk for obesity due to their immobility, as well as their disease modifying agents, and thus a decrease in these variables would be meaningful. That only percent of fat at the neck and hip decreased significantly has questionable significance related to the risk of cardiovascular disease. However, any decrease in body fat would be useful if it leads to increase ease of functional activities. This needs to be evaluated further.

The significant functional changes in walking endurance, as measured with the 6 minute walk test, are also of interest. Similar improvements have been noted previously after exercise in people with MS [34-36,38,39]. Performance on the 6 minute walk test has been shown to correlate strongly with both the EDSS and the MS Walking Scale 12, [38,39] and therefore these increases in endurance may positively impact daily activities, and potentially participation. This should be studied further with programs providing this level of exercise on an ongoing basis.

Limitations

Several limitations preclude the generalizability of these findings to the MS population as a whole. First, this was not a controlled trial, but represents analysis of data collected to measure outcomes in a clinically-oriented program. Therefore, there are many variables that may have impacted the findings. For instance, there was no control group, either of people who did not participate in the exercise program or who received a different intervention. There was no control over the number of exercise or educational sessions attended. The program was completely voluntary and clients could attend any or all classes they chose. Although attendance was taken, and the participants attended sessions fairly regularly (62%-84%), determining a dose-response from the current data is not feasible. Furthermore, perceived exertion was not collected from each individual, so it is difficult to know the participant's perception of how hard they were working. There were also no other measures of intensity, so it is difficult to compare the findings from this study to others, or to draw any conclusions about the efficacy of any of the interventions included in this program. Finally, the sample of participants for this study included only one person with primary progressive MS, and the remainder had relapse-remitting MS. Future studies should explore the benefits of a similar program for a larger population, and specifically in people with progressive MS. Information was not collected related to the education classes that participants in the wellness program attended. Future studies should consider standardizing the classes in order to better understand the relative contributions of different types and dosing of exercises for health and functional gains.

Conclusion

An outpatient MS exercise program may provide people with MS an alternative method for exercising that is feasible. Initial outcome measures show a positive effect in a subgroup of participants involved in classes guided by an instructor educated in MS. Assessment of outcomes related to real life interventions, however, may be a meaningful approach to explore more fully in order to gain greater insight into what approaches will lead to the greatest function, health and wellness for people with MS.

Further research is warranted and necessary. A controlled study focused on evaluating the efficacy of the various components of this program is necessary in order to determine the combination of exercise and educational variables that will lead to the most efficacious outcomes for any given individual with MS.

Conflict of Interest

The authors declare that they have no conflict of interest.

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