Research Report

Effects of Short Versus Long Bouts of Aerobic Exercise in Sedentary Women With Fibromyalgia: A Randomized Controlled Trial

Background and Purpose. The purposes of this study were: (1) to assess the effectiveness of a 16-week progressive program of home-based, videotape-based, low-impact aerobic exercise on physical function and signs and symptoms of fibromyalgia in previously sedentary women aged 20 to 55 years and (2) to compare the effects of 1 long exercise bout versus 2 short exercise bouts per training day (fractionation) on physical function, signs and symptoms of fibromyalgia, and exercise adherence. Subjects. One hundred forty-three sedentary women were randomly assigned to 1 of 3 groups: a group who trained using a long bout of exercise (LBE group, n=51), a group who trained using short bouts of exercise (SBE group, n=56), and a group who performed no exercise (NE group, n=36). Methods. The SBE group exercised twice daily, and the LBE group worked out once daily. Both groups progressed in total daily training duration from 10 to 30 minutes, 3 to 5 times a week, for 16 weeks. Physical and psychological well-being, symptoms, and self-efficacy were evaluated using a multivariate analysis of variance. Results. Dropout rates for the NE, SBE, and LBE groups were 14%, 38%, and 29%, respectively. The NE group differed from the LBE group in disease severity, self-efficacy, and psychological well-being (midtest, efficacy analysis) and from the SBE group in disease severity and self-efficacy (posttest, efficacy analysis). Exercise adherence was greater for the LBE group than for the SBE group between weeks 5 and 8 of the training program. No other differences between exercise groups were found. Discussion and Conclusion. Progressive, home-based, low-impact aerobics improved physical function and fibromyalgia symptoms minimally in participants who completed at least two thirds of the recommended exercise. Fractionation of exercise training provided no advantage in terms of exercise adherence, improvements in fibromyalgia symptoms or physical function. High attrition rates and problems with exercise adherence were experienced in both exercise groups. [Schachter CL, Busch AJ, Peloso PM, Sheppard MS. Effects of short versus long bouts of aerobic exercise in sedentary women with fibromyalgia: a randomized controlled trial. *Phys Ther.* 2003;83:340–358.]

Key Words: *Aerobic exercise training, Exercise fractionation, Fibromyalgia, Home exercise program, Randomized controlled trial, Split sessions.*

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Fibromyalgia is a chronic painful condition of unknown etiology. The prevalence rate for people of all ages is 2% (women=3.4%, men=0.5%); prevalence increases with age, with prevalence rates of 7.1% and 1.2%, respectively, for women and men aged 60 to 69 years.[1] The current diagnostic criteria include widespread pain for longer than 3 months' duration and pain on palpation of at least 11 of 18 specified tender points on the body.[2] A broader picture of fibromyalgia, presented in a 1996 consensus report,[3] describes a syndrome with widespread pain, decreased pain threshold, and characteristic symptoms, including sleep disturbances, fatigue, stiffness, mood disturbance, irritable bowel syndrome, headache, paresthesias, and other less common features.

Fibromyalgia is a frequently nonremitting condition that "affects every aspect of life and causes pronounced impact on work, family life and leisure."[4(p40)] Limitations in activities of daily living have been reported to be as great in people with fibromyalgia as those in people with rheumatoid arthritis.[5] Researchers have reported on the impact of fibromyalgia on work and productivity: (1) 20% to 50% of people with fibromyalgia could work few or no days,[6,7] (2) 36% of people with fibromyalgia had an average of 2 or more absences from work per month,[8] and (3) 26.5% to 55% of people with fibromyalgia had received disability or social security payments.[7,8]

Researchers have examined numerous interventions for fibromyalgia, including pharmacologic and psychotherapeutic interventions. Current methods achieve symptom relief for fewer than 50% of patients.[9,10] Exercise has gained acceptance as one component of management of fibromyalgia.[9–11] Aerobic exercise training, as described in a systematic review,[12] appears to have a modest effect on physical function and some symptoms

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of fibromyalgia. Researchers have examined a number of modes of supervised aerobic exercise training, including cycle ergometry[13]; walking indoors[14,15]; and walking, jogging, or side stepping in water.[16] Gowans et al[16] reported improvements in 6-minute walking time, Fibromaylgia Impact Questionnaire (FIQ) subscales of well-being (days felt good), and sleep, but not in pain, physical impairment, anxiety, depression, or self-efficacy, in a water exercise group as compared with a control group. Nichols and Glenn[15] reported improvements on 2 psychological function measures in people who participated in a walking program but a decrease in self-reported physical function and no change in pain. Using a combination of cycle ergometry, exercises to increase muscle force, and stretching, Martin et al[14] reported improvement in number of active tender points and cardiovascular fitness, with no changes in pain, FIQ total score, or self-efficacy. McCain et al[13] compared an aerobic training program using cycle ergometry with a program of flexibility exercise and reported improvement in the cycling group over the flexibility group in pain pressure threshold, cardiovascular fitness, and participant-rated and physician-rated disease severity, with no changes in pain intensity, sleep disturbance, or psychological measures.

As the importance of regular exercise and physical activity for health are increasingly recognized,[17] researchers have begun to examine the effect of performance of 2 or more shorter bouts of at least 10 minutes of exercise (fractionation) in lieu of 1 longer bout of exercise per day. In a systematic review of the effects of fractionation of exercise, Hardman[18(pS422)] reported that although more research is needed, "improvements in cardiorespiratory fitness, regimens comprising several short sessions of exercise per day are as effective as those comprising longer continuous sessions," but that there is currently no evidence for health outcomes such as long-term changes in body mass and blood lipid profile. Fibromyalgia, as well as many orthopedic and other rheumatologic conditions, is associated with pain that limits physical activity and prohibits or seriously detracts from a person's ability to engage in long, continuous bouts of physical activity. Multiple bouts of exercise of short duration interspersed throughout the day might be both practical and beneficial in improving functional capacity. Clark[19] suggested that individuals with fibromyalgia should reduce duration and increase frequency of exercise in order to perform enough exercise to improve fitness. While this makes intuitive sense, the benefits of such changes have not been demonstrated. We examined the effects of exercise fractionation in our study.

Although home-based exercise has been shown to be effective in improving physical fitness and superior to supervised exercise in promoting exercise adherence in older adults,[20] the effect of well-structured, home-based exercise training for individuals with fibromyalgia has not been studied extensively as an independent intervention. Ramsay et al[21] compared 12 weeks of home-based aerobic exercise with and without a once-a-week group session in people with fibromyalgia. They found no difference between the formats in terms of pain intensity, tenderness, and self-reported disability. Greater reduction in anxiety, as measured by the Hospital Anxiety and Depression Questionnaire, however, were achieved in the once-a-week group session. Meyer and Lemley[22] compared low- and high-intensity, home-based progressive walking programs for people with fibromyalgia, but they did not demonstrate any change in physical function or in signs and symptoms of fibromyalgia between groups. No control groups were used in the studies by Ramsay et al[21] and Meyer and Lemley,[22] so the effectiveness of the home programs remains unknown. Home-based, videotape-based, low-impact aerobic exercise training has not been studied.

The purposes of our randomized controlled trial were: (1) to assess the effectiveness of a 16-week progressive program of home-based, videotape-based, low-impact aerobic exercise on physical function and signs and symptoms of fibromyalgia in previously sedentary women aged 20 to 55 years and (2) to compare the effects of short versus long bouts of exercise of equal daily training intensity and duration on physical function, signs and symptoms of fibromyalgia, and adherence to exercise.

Method

Subjects

Participants were recruited by referral from rheumatologists, family physicians, and physical therapists; through posters in physicians' offices and physical therapy clinics; and through advertisements in local newspapers. Inclusion criteria were: women aged 20 to 55 years living in Saskatoon (Saskatchewan, Canada) area, diagnosis of fibromyalgia (American College of Rheumatology [ACR] 1990 diagnostic criteria[2]), sedentary, permission of the family physician for participation, and willingness to provide informed consent and to be randomly assigned to treatment or control groups. *Sedentary* was defined as no participation in regular physical activity more strenuous than slow-paced walking a maximum of 2 times a week over 4 months prior to study entry. Women were excluded from the study if they had more than 2 coronary artery disease factors outlined in the 1995 guidelines of the American College of Sports Medicine (ACSM)[23(p18)]; known cardiovascular or respiratory disease; or metabolic, musculoskeletal, or neurological conditions that would interfere with performance of moderate-intensity aerobic exercise.

Table 1.
Baseline Characteristics of Participants by Intervention[a]

Variable	NE Group	SBE Group	LBE Group
Group size	36	56	51
Age (y)			
$\bar{X}$	42.5	41.9	41.3
SD	6.69	8.57	8.67
Range	23–53	20–54	20–53
Race			
Caucasian	94.3%	98.1%	100%
Aboriginal	2.9%	0%	0%
Hispanic	2.9%	1.9%	0%
Duration since diagnosis (y)[b]			
$\bar{X}$	3.6	3.5	2.9
SD	3.21	2.86	2.76
Range	0–15.3	0–11.6	0.1–13.3
Duration since onset of symptoms (y)[c]			
$\bar{X}$	8.8	8.6	8.8
SD	4.97	6.04	6.18
Range	0.9–9.6	0.3–32.7	0.5–22.4
FIQ–total score			
$\bar{X}$	5.5	5.4	5.6
SD	1.33	1.49	1.43
Range	2.5–8.8	1.0–7.9	3.3–9.1
Education			
8–12 y	41.7%	21.8%	32.0%
≤13 y	58.3%	78.2%	68.0%
Lives with spouse or partner (yes)	25.7%	14.5%	19.6%
Work			
Full-time	55.6%	52.7%	50.0%
Part-time	27.8%	12.7%	28.0%
Housework	8.3%	14.5%	10.0%
Disabled	5.6%	9.1%	2.0%
Unemployed	2.8%	1.8%	4.0%
Student	0%	9.1%	6.0%
Current smoker (yes)	22.2%	23.6%	14.9%
Disability payment in past or present (yes)	13.9%	11.3%	18.4%

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, FIQ=Fibromyalgia Impact Questionnaire.
[b] NE group, n=33; SBE group, n=48; LBE group, n=47.
[c] NE group, n=22; SBE group, n=41; LBE group, n=36.

A total of 143 women were randomly assigned to 1 of 3 groups: a group that trained using a long bout of exercise (LBE group, n=51), a group that trained using short bouts of exercise (SBE group, n=56), and a group that performed no exercise (NE group, n=36). The baseline characteristics of the participants by intervention are presented in Table 1.

Procedure

Potential participants underwent an initial examination by a rheumatologist to confirm the diagnosis of fibromyalgia, to screen for exclusion criteria, and to evaluate physician-rated disease severity. Eligible individuals who provided informed consent were scheduled for an exercise pretest. After completion of the pretest, participants were assigned to groups using a random number sequence prepared by a member of the faculty of the School of Physical Therapy who was not connected with the study. Each of the 3 groups was composed of a number of small groups. Participants in each small group attended monthly group meetings led by a physical therapist or a physical therapist student as they progressed through the study. Small-group meetings were scheduled on different days to prevent interaction between participants assigned to different interventions. Two modifications to the randomization method were implemented during the 2-year data collection period. After randomly assigning 55 participants to groups, we switched from simple random assignment by individual to assignment of participants to blocks (that became small groups) of subjects who were randomly assigned to receive 1 of 3 interventions. This reduced the waiting time between screening and the formation of each small group. After randomly assigning 100 participants, but prior to data analysis, when it was determined that attrition was higher in the exercise groups, we modified our procedure again and assigned 2 blocks to the SBE and LBE groups for every single block assigned to the NE group. Initially, the number of participants randomly assigned to each small group was 5; using the block strategy, small-group size was readjusted to 12.

LBE and SBE groups. The 16-week progressive low-impact aerobics programs performed to music were designed by the researchers and a Young Women's Christian Association-certified fitness trainer/instructor. Videotapes of the LBE and SBE programs, led by the same fitness instructor, were produced by the University of Saskatchewan, Department of Audio Visual Services and the researchers. A videotape of the exercise and an accompanying instruction booklet as well as exercise and daily symptom logbooks were provided to each participant.

The exercise programs as shown in the videotapes included a warm-up segment, a training segment, and a cool-down segment, all performed to music. The LBE and SBE warm-up and cool-down segments were identical; the training segments differed only in length. The training segment consisted of rhythmic movements

Table 2.
Guidelines for Progression of Exercise Intensity and Duration

Week	Target RPE[a]	Target Intensity (% Heart Rate Reserve)	Frequency (Times per Week)	Short Bout Duration (Minutes per Bout, Twice a Day)	Long Bout Duration (Minutes per Bout, Once a Day)
1	10–11	40%–50%	3	5	10
2	10–11	40%–50%	3	6	12
3	11–12	45%–55%	3	7	14
4	12–13	50%–60%	3	9	18
5	12–13	50%–60%	3–4	10	20
6	12–13	50%–60%	3–4	12	24
7	12–13	55%–65%	3–4	13	26
8	12–13	55%–65%	3–4	14	28
9	12–13	55%–65%	3–4	15	30
10	12–13	60%–70%	3–4	15	30
11	12–13	60%–70%	3–5	15	30
12	13–14	65%–75%	3–5	15	30
13	13–14	65%–75%	3–5	15	30
14	13–14	65%–75%	3–5	15	30
15	13–14	65%–75%	3–5	15	30
16	13–14	65%–75%	3–5	15	30

[a] RPE=rating of perceived exertion.

designed to use all major muscle groups of the lower extremities, but with minimal involvement of upper extremities. The warm-up and cool-down segments each consisted of 5 minutes of rhythmic movements and stretching exercises (weight bearing during warm-up, non–weight bearing during cool-down). The rhythmic movements listed in the Appendix were used in all 3 components of the exercise program. Movements were switched frequently to avoid local fatigue, and the eccentric component of movements was de-emphasized to minimize delayed muscle soreness.[24]

The SBE program was to be performed during 2 sessions per day separated by at least 4 hours. The SBE training segment duration began at 5 minutes per session, was progressed to 15 minutes per session by week 9, and was maintained at 15 minutes per session through week 16. The LBE program was to be performed once daily; the training segment duration was progressed from 10 minutes per session to 30 minutes per session by week 9 and was maintained at 30 minutes until the end of the program. Although the LBE and SBE daily training segment durations were equal, total daily program duration was 10 minutes greater per day for the SBE program because participants did the warm-up and cool-down segments twice daily, whereas these segments were done only once by those in the LBE program.

Exercise intensity was modulated through changes in music tempo, participant adjustment of vigor of exercise performance and use of heart rate and rating of perceived exertion (RPE)[23(p77)] targets. The music tempos were 114 beats per minute (bpm) during warm-up exercises and 108 bpm during cool-down exercises. The training segment music tempo was progressed from 126 bpm for the first one third of training segment to 132 bpm for the middle one third of the training segment and then to 144 bpm for the final one third of the training segment. To address exercise intensity by changing vigor of performance, participants were instructed to alter the size of steps and the vertical amplitude of their movements. The instructor on the videotape repeatedly explained and demonstrated these techniques and frequently encouraged the exerciser to adjust exercise intensity as appropriate. Leaders of the small groups encouraged each participant to exercise at target intensities, but also suggested that if a participant experienced increased fatigue or pain, she should try to complete the recommended exercise duration for that session at a lower intensity.

Individualized target heart rates for each participant were calculated using the formula (220 − age) to predict maximum heart rate[23(p274)] and the Karvonen heart rate reserve (HRR) method.[23(p274)] Because we anticipated pain and low levels of fitness, target exercise intensities for the training segment of the programs began at 40% to 50% of HRR during week 1, were progressed to 65% to 75% of HRR by week 12, and were held constant at that level between weeks 12 and 16 (Tab. 2). Intensity was described to participants in terms of target heart rates (beats per 10 seconds) and RPE (6–20 scale[23(p68)]).

Participants were asked to check their logbooks before each exercise session to identify the appropriate exercise training time and RPE and were reminded by the instructor on the videotape to exercise for the appropriate length of time. Visual timing cues (elapsed exercise

Table 3.
Constructs and Variables Measured[a]

Construct	Individual Variables Included
Physical function	Peak oxygen uptake, Duration-of-Exercise Test, FIQ–impairment, AIMS2–walking and bending, AIMS2–mobility
Symptoms	FIQ–rested upon waking, FIQ–fatigue, FIQ–stiffness
Disease severity	Physician rating of global severity, FIQ–total score
Pain and tenderness	Pain (VAS), number of painful body regions, tender points (tenderness on palpation), and total myalgic scores (dolorimetry)
Self-efficacy	Self-Efficacy for activities of daily living scale, self-efficacy for control of pain, and self-efficacy for control of other symptoms
Psychological well-being	FIQ–feel good, FIQ–anxious, FIQ–depressed, AIMS2–affect

[a] VAS=visual analog scale, FIQ=Fibromyalgia Impact Questionnaire, AIMS2=Arthritis Impact Measurement Scale2.

training time followed by a 10-second time sweep graphic) were provided in the corner of the viewing screen at the end of each minute to cue the participant to find her pulse and take a 10-second exercise heart rate count at the end of the training segment. Until week 9 (when the training time reached the full training time), participants forwarded the videotape to the cool-down section to begin the cool-down exercises as soon as they had recorded their exercise heart rates and RPE in their logbooks.

Participants were asked to attend monthly meetings of their small group. During the first meeting, the group leader taught participants how to manually measure heart rate, determine RPE, and complete exercise logs. Participants also received instruction and practice in altering exercise intensity by changing the size of their steps and the vertical amplitude of their movements and in applying these techniques when their heart rate or RPE did not correspond to the target values. Subsequent meetings focused on problem solving related to difficulties with the exercise program and on providing further assistance with the adjustment of exercise intensity. The final meeting focused on ways to enhance post-study physical activity and exercise level and adherence.[25] The group leader telephoned each participant every 4 weeks, midway between group meetings, to provide encouragement and help the participant solve problems related to exercise difficulties.

NE group. Participants in this group were asked to maintain their sedentary lifestyle for the duration of the study and to attend monthly small-group meetings, during which participants discussed their experiences with fibromylagia. No educational content was provided by the researchers. The group leader telephoned each participant every 4 weeks, midway between group meetings, to inquire about her status. The participants also were asked to record symptoms in a daily symptom log. All individuals in the NE group were offered the videotape and exercise program instruction upon their completion of the study.

We did not control for physician visits or medications, but we did ask participants to refrain from starting any new regular physical activity or exercise programs (that were unrelated to the study) or other nonpharmacological interventions for fibromylagia during their 16-week involvement.

Outcome Measures

At the time of the pretest (0 weeks), midtest (8 weeks), and posttest (16 weeks), participants completed the exercise test, the FIQ, the Body Pain Diagram, the Arthritis Impact Measurement Scales2 (AIMS2), and the Chronic Pain Self-Efficacy Scale (CPSS). One rheumogologist who was masked to group assignment conducted all tender point examinations[2,26,27] and evaluated fibromyalgia severity of all participants before starting and after completing the study.

The lack of consensus on which outcome measures should be used to demonstrate the effects of exercise[12] led us to use a large number of outcome measures in our study. We chose outcome variables in an attempt to measure different aspects of, or perspectives on, fibromyalgia. We organized these outcome variables into 6 groups (constructs): physical function, symptoms, disease severity, pain and tenderness, self-efficacy, and psychological well-being (Tab. 3) as a way to conceptualize the signs and symptoms of fibromyalgia and the areas that might be affected by an intervention.

Based on evaluation of the 18 ACR-specified fibromylagia tender point sites,[2] we obtained 2 measurements: mean myalgic score and physician-rated tenderness on thumb pressure. A dolorimeter* was used to measure the pain pressure threshold at the 18 tender points. The pain pressure thresholds were averaged to yield a mean myalgic score. In pilot work, we found a high degree of intrarater reliability for means of pain pressure thresholds for the 18 fibromyalgia tender points from 2 trials (n=4, intraclass correlation coefficient [ICC] for ran-

* Pain Diagnostics and Thermography, 17 Wooley Ln E, Great Neck, NY 11021.

dom effects and absolute agreement=.925). This finding, however, was based on only 4 measurements, and therefore it should be viewed with caution. Myalgic scores are a frequently used outcome measure in controlled trials for fibromyalgia.[28] The observer rated tenderness on thumb palpation at the same 18 tender points using a 5-point scale (0="no pain expressed"; 1="pain expressed verbally"; 2="pain expressed, winced, slight withdrawal"; 3="exaggerated withdrawal response"; and 4="unable to touch").[29,30] Thumb tenderness scores have been shown to have good internal consistency in people with fibromyalgia over a 1-week interval (alpha coefficient=.74).[30]

We used body pain diagrams to characterize the distribution of pain. Subjects shaded unmarked body diagrams of anterior and posterior surfaces of the body to reflect areas in which they experienced pain. By superimposing a transparent template that divided the body into 45 regions,[31] we counted the number of areas reported as painful. Reliability estimates for scoring of pain distribution on body pain diagrams have been shown to be .997 for interrater reliability (using 101 diagrams from patients with low back pain[31]) and .85 for test-retest reliability (51 patients with chronic pain completed diagrams twice over an average interval of 71 days[32]). These diagrams have been used successfully to measure response to exercise interventions in people with fibromyalgia.[13,33]

Cardiorespiratory fitness was measured using a modified Balke protocol on a calibrated Quinton Q50 treadmill fitted with a model 645 programmable controller.† Oxygen uptake ($\dot{V}O_2$) was measured using a TEEM 100 metabolic analyzer‡ that was calibrated each day before use. Peak $\dot{V}O_2$ and exercise test duration were recorded. We used ACSM guidelines for termination of a maximal exercise test.[23(p78)] Participants were monitored during and after the exercise test with a Lifepak 6, 3-lead electrocardiograph§ for basic disturbances in cardiac rhythm. Care was taken to ensure that study staff used strictly standardized testing procedures, including standardized verbal encouragement.

We used a revised and expanded version of the AIMS (AIMS2)[34] to obtain 2 self-reported measurements of physical function (Walking and Bending scale and Mobility scale scores) and 1 measurement of psychological well-being (Affect scale score). The AIMS2 is a health status questionnaire comprising several individual scales that have been used in fibromyalgia research.[1,5,35,36] The reliability (test-retest ICCs for 2 administrations of the questionnaire separated by 2–3 weeks in 45 patients with rheumatoid arthritis and osteoarthritis) was .91 for the Mobility scale and .92 for the Walking and Bending scale.[34] The AIMS2 Affect scale has been found to correlate with 3 external health status measures.[34]

We used the FIQ[37] to measure participant-rated overall severity of fibromylagia, intensity of pain, severity of common symptoms, and physical impairment of individuals with fibromylagia. The FIQ was designed to measure severity of fibromyalgia through evaluation of physical impairment (using 10 Likert items) and fatigue, restfulness on waking, stiffness, anxiety, depression, and the degree to which pain or other symptoms interfere with ability to work (using 10-cm visual analog scales [VASs]). Construct validity and test-retest reliability have been examined in 64 women with fibromyalgia.[37] Construct validity was demonstrated through correlations of FIQ scores for physical impairment, pain, depression, and anxiety of with respective AIMS2 scores (r=.67–.76). Test-retest reliability was examined over six 1-week intervals and was reported to be r=.95 for physical impairment; r>.70 for ability to do job, anxiety, and depression; and r>.56 for pain, stiffness, fatigue, and morning tiredness.[37]

A rheumatologist, masked to group assignment, rated the severity of fibromylagia on a 10-cm VAS (0="no problems," 10="problems as bad as they could be") before and after the interventions. White and Harth[28] reported that physician-rated global assessments were used as an outcome measure in 11 of 24 controlled trials for fibromylagia. Although we were unable to find reliability data for physician ratings of disease severity, some studies have demonstrated the validity of the physician ratings. Daniel et al[38] found a good level of agreement between physician-rated and patient-rated treatment outcomes in patients with chronic pain (Spearman rho=.641). Von Korff et al[39] also demonstrated good concurrent validity between physician ratings of disease severity and chronic disease scores (Pearson r=.57) in a random sample (N=722) of patients with several chronic diseases.

The CPSS was used to measure participants' beliefs about their capabilities to produce effects (self-efficacy) in 3 specific areas.[40] The CPSS consists of 22 Likert items that require subjects to rate how confident they are that they can manage their pain, manage other symptoms, and perform functional tasks.[41] Scores for the CPSS have strong concurrent and construct validity when the test is used by patients with chronic pain; CPSS scores correlate inversely with depression and hopelessness scores (Pearson correlation coefficients range from r=−34 to

† Quinton Instrument Co, 3303 Monte Villa Pkwy, Bothell, WA 98021.
‡ Medgraphics Corp, 350 Oak Grove Pkwy, St Paul, MN 55127.
§ Medtronic Physio-Control, 11811 Willows Rd NE, PO Box 97006, Redmond, WA 98073-9706.

$r=-.62$).[41] There are no published reliability data for the CPSS, but the test closely parallels the Arthritis Self-Efficacy Scale, which has good test-retest reliability (item by item: $r=.71–.85$, function subscale: $r=.85$, other symptoms subscale: $r=.90$, and pain subscale: $r=.87$).[42]

Participants in the SBE and LBE groups were asked to record pre-exercise and post-exercise pain, heart rate immediately after exercise, duration of exercise, RPE, and any difficulties with exercise in an exercise log. All participants were asked to rate global feelings about symptoms of fibromylagia, sleep, fatigue, and pain each morning in the daily symptom log.

Participant Adherence

Exercise adherence encompasses the intensity, duration, and frequency of exercise performed as compared with exercise that has been recommended. Because of widespread participant difficulty measuring heart rate and RPE (as reflections of intensity of performed exercise), we used exercise duration and frequency to represent adherence, examining exercise adherence in four 4-week phases. A duration index for each phase was calculated by dividing the sum of the minutes of exercise performed within a phase (as recorded in the participant's exercise log) by the minimum number of minutes of exercise recommended for that period. We classified duration indexes into 5 categories: "little or no exercise" ($\leq$0.13), "marginal" (0.14–0.66), "below recommended" (0.67–0.89), "met minimum recommended" (0.90–1.00), and "exceeded minimum recommended" (>1.00). We considered that participants met the minimum recommended when they completed the equivalent of 11 or 12 of the 12 recommended sessions over 4 weeks for LBE or 22 to 24 of the 24 recommended sessions for SBE and that their performance fell below the minimum recommended when they completed the equivalent of between 8 and 10 of the 12 recommended LBE sessions or 16 to 20 for the 24 recommended SBE sessions in 4 weeks.

Data Analysis

To minimize false positive results when analyzing the sizable number of outcomes in our study, we used a repeated-measures multivariate analysis of variance (MANOVA) on constructs; interactions were examined using the Tukey honestly significant difference (HSD) *post hoc* comparison of means with a Bonferroni correction (SAS software program, version 8[‖]. We used one-way analyses of variance (ANOVAs) to compare groups at pretest, chi-square tests, and repeated-measures ANOVAs (SPSS software program, version 10.0.5[#]) with Tukey HSD *post hoc* comparison of means to analyze exercise adherence data. The one-way ANOVAs revealed no initial differences among groups in age, demographic attributes, duration since onset of symptoms, or any outcome variables at baseline measurement (Tab. 1). A significance level of $P<.05$ was used.

We used an intention-to-treat (ITT) analysis[43] on the pretest and posttest scores to address the effects of the interventions on participants regardless of whether they completed the study or adhered to the exercise regimen. Using the principle of last observation carried forward, missing posttest scores were filled using the test scores collected closest to the time of dropout.

To examine whether the interventions were effective for participants with good adherence, we conducted a secondary efficacy analysis using a subset of participants who were adherent, defined as participants in the NE group who completed the study and participants in the LBE and SBE groups who had completed at least 66.7% of the prescribed exercise duration, based on exercise log data. We chose this criterion to represent the equivalent of an exercise frequency of twice per week, which has been shown in the literature to facilitate a training effect.[44] In the efficacy analysis, we analyzed pretest, midtest, and posttest data to determine whether any changes occurred in each half of the training program.

Because both symptoms and cardiorespiratory measures were central to our study, a sample size (n=33) was calculated[45] prior to beginning the study such that we would have an 80% chance of finding a between-group difference of 1.10 cm on the pain VAS and 3 $mL \cdot kg^{-1} \cdot min^{-1}$ in peak $\dot{V}O_2$.

Results

Attrition and Adverse Effects

Dropout rates were 14%, 38%, and 29%, in the NE, SBE, and LBE groups, respectively. Reasons for dropping out included increases in time commitments at work or with family; exercises were too time consuming or boring; a change in the willingness of participants to accept their randomized group assignment; increased pain, stiffness, or fatigue; not enough room or a lack of privacy to perform exercise; and a car accident. There were no differences between the initial values of any of the variables for individuals who dropped out compared with those who completed the study (Tab. 4). One participant assigned to the SBE group withdrew after developing metatarsal stress fracture.

Effects of Intervention—ITT Analysis

Table 5 shows the means, standard deviations, and ranges for all groups at the time of the pretest and after

[‖] SAS Institute Inc, SAS Campus Drive, Cary, NC 27513.
[#] SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

Table 4.
Characteristics of Dropouts by Intervention Versus Participants Who Completed Program[a]

Variable	Participants Who Completed Program	Dropouts		
		NE Group	SBE Group	LBE Group
N	102	5	21	15
Age (y)				
$\bar{X}$	42.5	43.8	41.0	38.0
SD	7.62	5.81	10.06	8.71
Range	21–54	38–53	20–54	20–52
Duration since onset of symptoms (y)[b]				
$\bar{X}$	8.7	7.5	9.9	7.1
SD	5.30	3.64	7.28	7.08
Range	0.3–22.4	3.3–9.8	1.2–32.7	0.5–20.5
FIQ–total score				
$\bar{X}$	5.6	5.3	5.5	5.7
SD	1.50	2.03	1.58	1.29
Range	1.0–9.1	3.9–8.75	2.5–7.9	4.0–8.1
Pain (VAS)				
$\bar{X}$	5.9	5.6	6.2	5.7
SD	2.11	2.02	2.54	1.45
Range	1.2–10	3.4–8.7	1.9–9.9	2.7–7.4
Peak oxygen uptake ($mL \cdot kg^{-1} \cdot min^{-1}$)				
$\bar{X}$	23.5	22.5	23.7	23.7
SD	4.74	2.40	5.33	4.70
Range	13.9–36.4	18.7–24.6	15.5–33.7	16.1–31.8
Physician rating of global severity				
$\bar{X}$	5.1	5.4	5.1	4.8
SD	1.70	1.89	1.72	1.58
Range	2.0–8.9	3.4–8.1	3.1–7.8	1.7–7.4

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, VAS=visual analog scale, FIQ=Fibromyalgia Impact Questionnaire.
[b] Participants who completed program=68; NE group, n=3; SBE group, n=17; LBE group, n=11.

16 weeks for all 143 participants. Although a univariate analysis demonstrated that there were no between-group differences in any individual outcome variable at the time of the pretest, the MANOVA indicated that a difference existed in physical function at the time of the pretest between the SBE and NE groups (P=.017). A difference in physical function between the SBE and NE groups was again observed at the time of the posttest (P=.037). There were no differences between either exercise group and the NE group for symptoms, disease severity, pain, self-efficacy, or psychological well-being. No differences between the SBE and LBE groups were found for any construct. A summary of these results is given in Table 6.

Several within-group differences were found in the ITT analysis. Both the SBE and LBE groups improved over time in disease severity (P=.016 and P=.0009, respectively). The LBE group also showed improvements over time in psychological well-being (P<.0001) but not in physical function (P=.056). The NE group showed changes in physical function, with slightly lower posttest results for peak $\dot{V}O_2$ and AIMS2 Walking and Bending scale scores and with slight improvements in exercise test duration and FIQ impairment scale scores (P=.020). The NE group also demonstrated improvements in pain (P=.001).

Effects of Intervention—Efficacy Analysis

Of the 143 participants in the study, 86 participants (31 in the NE group, 26 in the SBE group, and 29 in the LBE group) met the criteria for inclusion in the efficacy analysis. Table 7 shows the means, standard deviations, and ranges for participants who were adherent at pretest, midtest, and posttest.

The efficacy analysis showed differences between the NE group and participants who were adherent in the LBE group at midtest in disease severity (P=.01), self-efficacy (P=.034), and psychological well-being (P=.041). At the time of the posttest, disease severity of the adherent participants in the SBE group was less than that of participants in the NE group (P=.047) and self-efficacy was greater than that of participants in NE (P=.001). There were no differences between the exercise groups. A summary of these results is given in Table 8.

Some within-group differences in participants who were adherent were found. In the SBE group, improvements in disease severity (P=.0006) and self-efficacy (P=.020) were noted. In the LBE group, improvements were found in physical function (P=.005), disease severity (P<.0001), symptoms (P=.010), self-efficacy (P=.043), and psychological well-being (P<.0001). Improvements in pain (P=.046) also were found in the NE group.

Table 5.
Means, Standard Deviations, and Ranges for Outcome Variables at Baseline and at 16 Weeks by Intervention for Intention-to-Treat Analysis (N=143)[a]

Construct	Variable	Pretest			Posttest		
		NE Group (n=36)	SBE Group (n=56)	LBE Group (n=51)	NE Group (n=36)	SBE Group (n=56)	LBE Group (n=51)
Physical function	Peak oxygen uptake ($mL \cdot kg^{-1} \cdot min^{-1}$)						
	$\bar{X}$	23.5	23.3	23.6	22.3	23.6	24.3
	SD	4.27	4.87	4.95	4.28	4.81	5.34
	Range	13.9–32.7	14.2–33.7	14.5–36.4	14.5–30.6	11.7–33.7	14.4–39.1
	Duration (s)						
	$\bar{X}$	593	631	638	608	629	671
	SD	150.8	142.6	147.5	115.2	138.5	151.2
	Range	187–830	218–943	200–919	447–886	267–1,000	216–946
	FIQ–Impairment						
	$\bar{X}$	3.8	3.1	3.7	3.6	2.7	3.2
	SD	1.86	2.42	2.03	2.24	2.34	2.41
	Range	0.8–8.2	0.0–8.3	0.0–7.3	0.0–9.3	0.0–8.7	0.0–9.3
	AIMS2–mobility						
	$\bar{X}$	1.4	2.0	2.0	1.4	1.7	1.9
	SD	1.21	1.70	1.57	1.31	1.72	1.69
	Range	0–4.5	0.0–5.5	0.0–5.6	0.0–5.5	0.0–6.5	0.0–6.0
	AIMS2–walking and bending						
	$\bar{X}$	4.1	4.6	4.4	3.6	4.2	3.8
	SD	2.02	1.94	1.91	2.34	2.28	2.11
	Range	0.0–8.0	0.0–8.0	0.5–8.0	0.0–10.0	0.5–8.5	0.0–8.5
Symptoms	FIQ–fatigue						
	$\bar{X}$	7.7	7.4	7.8	7.2	7.1	7.3
	SD	1.25	1.83	1.35	2.00	2.06	1.96
	Range	3.8–10.1	1.0–9.6	5.1–9.9	1.2–9.9	1.6–9.6	2.2–9.9
	FIQ–rested						
	$\bar{X}$	7.4	7.1	7.7	7.2	6.4	7.1
	SD	1.78	2.17	1.75	1.74	2.41	2.10
	Range	0.9–9.9	0.2–9.8	3.2–9.9	0.5–9.9	0.2–9.7	1.4–9.9
	FIQ–stiffness						
	$\bar{X}$	7.0	6.5	6.5	6.9	6.2	6.0
	SD	1.90	2.02	1.93	1.68	2.34	2.19
	Range	2.6–9.9	1.8–9.6	2.5–9.9	3.1–9.9	0.7–9.6	1.8–9.9
Severity	FIQ–total score						
	$\bar{X}$	5.5	5.4	5.6	5.4	5.2	5.1
	SD	1.33	1.49	1.43	1.55	1.82	1.74
	Range	2.5–8.8	1.0–7.9	3.3–9.1	1.2–8.8	1.1–8.9	1.2–8.7
	Physician rating of global severity						
	$\bar{X}$	5.3	4.9	5.1	4.8	4.2	4.4
	SD	1.62	1.70	1.72	1.62	1.66	1.76
	Range	2.5–8.4	2.0–8.9	1.7–8.6	1.4–8.1	1.3–7.8	1.2–8.0

(continued on next page)

Adherence

Forty-five of the 56 participants in the SBE group and 42 of the 51 participants in the LBE group completed the study and submitted exercise logs. Examination of the quantity of exercise performed during each 4-week phase of the program showed a gradual decline in numbers of participants exercising at recommended levels, with the steepest drop being in the final phase of the exercise program for the SBE group and between phases 2 and 3 for the LBE group. The proportions of participants in the SBE group who were exercising at or above the minimum recommended level across the 4 phases were 46%, 40%, 42%, and 22% as compared with 68%, 74%, 54%, and 41% in the LBE group. The

Table 5.
Continued.

Construct	Variable	Pretest NE Group (n=36)	Pretest SBE Group (n=56)	Pretest LBE Group (n=51)	Posttest NE Group (n=36)	Posttest SBE Group (n=56)	Posttest LBE Group (n=51)
Pain	Pain (VAS)						
	$\bar{X}$	6.1	5.7	5.8	5.6	5.8	5.3
	SD	1.97	2.26	1.75	2.16	2.48	2.27
	Range	1.2–10.0	1.4–9.9	1.6–9.9	0.3–9.9	0.4–9.9	0.7–9.9
	Body distribution						
	$\bar{X}$	21.7	22.7	22.9	21.4	20.6	22.1
	SD	11.28	9.12	7.89	10.51	10.51	10.85
	Range	0–42	7–40	7–41	0–41	6–43	0–42
	Dolorimetry						
	$\bar{X}$	3.7	3.8	3.8	3.6	3.9	3.8
	SD	1.01	0.94	1.04	1.04	1.17	1.07
	Range	1.9–6.5	1.8–6.0	1.7–6.9	2.0–7.3	1.8–7.1	2.0–8.3
	Thumb pressure						
	$\bar{X}$	2.0	1.9	1.9	1.8	1.8	1.7
	SD	0.42	0.40	0.39	0.57	0.51	0.44
	Range	1.0–3.0	1.1–3.1	1.0–2.7	0.6–3.0	0.6–3.1	0.6–2.7
Self-efficacy	Pain						
	$\bar{X}$	50.6	57.8	55.4	48.8	63.4	58.8
	SD	23.28	22.48	24.30	25.60	27.27	25.73
	Range	11.4–94.6	19.2–105.0	11.4–105.0	1.0–102.4	19.2–113.2	3.8–116.8
	Function						
	$\bar{X}$	69.0	74.21	69.6	71.0	74.9	73.2
	SD	25.04	28.40	28.08	29.70	28.87	29.12
	Range	11.1–106.1	14.0–116.4	12.6–118.0	1.0–115.1	4.9–118.0	11.2–118.0
	Symptoms						
	$\bar{X}$	55.5	63.1	53.1	55.7	68.0	58.7
	SD	19.95	21.33	19.44	24.65	25.17	24.39
	Range	7.5–95.3	12.4–109.9	4.3–103.5	7.5–104.6	21.1–118.0	7.5–113.1
Psychological well-being	FIQ–anxiety						
	$\bar{X}$	4.7	4.9	4.7	5.2	4.9	4.6
	SD	2.54	3.00	2.60	2.60	2.88	2.43
	Range	0.0–9.1	0.0–9.9	0.3–9.9	0.0–9.2	0.0–9.9	1.0–9.9
	FIQ–depression						
	$\bar{X}$	4.5	4.2	4.4	4.9	4.2	4.4
	SD	2.50	2.71	2.81	2.62	2.92	2.83
	Range	0.3–9.9	0.0–9.4	0.3–9.5	0.0–9.9	0.0–9.2	0.4–9.9
	AIMS2–affect						
	$\bar{X}$	4.6	4.7	4.6	4.4	4.4	4.2
	SD	1.42	1.66	1.45	1.54	1.80	1.74
	Range	1.5–7.75	1.3–8.0	1.8–7.3	1.3–7.3	0.0–8.0	0.8–7.3
	FIQ–feel good						
	$\bar{X}$	6.7	7.0	7.6	6.4	6.6	6.1
	SD	2.44	2.50	2.18	2.68	2.95	2.68
	Range	1.4–10.0	0.0–10.0	2.9–10.0	0.0–10.0	0.0–10.0	0.0–10.0

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, VAS=visual analog scale, FIQ=Fibromyalgia Impact Questionnaire, AIMS2=Arthritis Impact Measurement Scale2.

exercise duration index values across the 4 phases are shown in the Figure. In phase 2, participant adherence was greater in the LBE group than in the SBE group, as illustrated by greater duration index values and different distributions among adherence categories.

Discussion and Conclusion

We set out to examine the questions: (1) Does a 16-week progressive program of home-based, videotape-based, low-impact aerobic exercise affect physical function or signs and symptoms of fibromyalgia for previously sed-

Table 6.
Summary of Results of *Post Hoc* Comparisons With Bonferroni Corrections for Intention-to-Treat Analysis (N=143)[a]

Construct	*Post Hoc* Between-Group Comparisons With Bonferroni Correction	*Post Hoc* Within-Group Comparisons With Bonferroni Correction
Physical function	Pretest SBE vs NE (*P*=.017)	NE (*P*=.020)
	Posttest SBE vs NE (*P*=.037)	
Symptoms	NS	
Disease severity	NS	SBE (*P*=.016) LBE (*P*=.0009)
Pain	NS	NE (*P*=.001)
Self-efficacy	NS	
Psychological well-being	NS	LBE (*P*<.0001)

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, NS=not significant (*P*>.05).

psychological well-being and the SBE group improving in only disease severity and self-efficacy.

Before comparing the effects of the interventions in our study with those observed in previous studies, it is important to recognize 3 distinct characteristics of our training programs: the use of low-impact aerobics (also called "aerobic dance"), the delivery method (a home-based, videotape-based program), and the format (1 bout versus 2 bouts). Although our design does not allow isolation of each of these components, we will discuss each component in light of the comparable literature, and we will offer our insights on each component.

entary women? and (2) What are the effects of fractionation of this exercise program on physical function, signs and symptoms of fibromyalgia, and exercise adherence?

Based on the results of the ITT analyses, it appears that neither exercise program had broad-ranging effects on fibromyalgia. No differences were seen between the LBE and SBE groups. There were differences in physical function between the SBE and NE groups at both pretest and posttest; pretest differences may obscure any improvements in physical function attributable to the exercise program. Considering the high attrition rates in the exercise groups, we were not surprised that few changes were found with the ITT analysis.

With the efficacy analysis, although a greater number of differences between either exercise group and the NE group were noted, no differences were noted between the exercise groups. When comparing the participants who were adherent in the LBE group with the participants in the NE group, transient improvements in disease severity, self-efficacy, and psychological well-being that were evident at the time of the midtest were not retained at the time of the posttest. This finding may relate to the higher level of exercise adherence observed between weeks 1 and 8 than between weeks 9 and 16. In contrast, the SBE group improvements were noted only at posttest, with improvements relative to the NE group in disease severity and self-efficacy.

There were more consistent within-group improvements among participants who adhered to the exercise program in the LBE group than in the SBE group, with the LBE group demonstrating improvements in physical function, symptoms, disease severity, self-efficacy, and

Is low-impact aerobic exercise a satisfactory mode of exercise for improving signs and symptoms of fibromyalgia? To answer this question, we add to our results the findings of 3 previous randomized clinical trials that examined the effects of supervised programs of aerobic dance[46,47] or a similar exercise mode[33] on fibromyalgia. Wigers et al[33] were alone in finding improvements in pain, dolorimetry, participant-rated disease severity, fatigue, and sleep in a group of participants who exercised compared with a control group of participants who did not exercise. Although our results for signs and symptoms of fibromyalgia were inconsistent for the SBE and LBE groups, we found improvements in disease severity and self-efficacy in the participants in the SBE group who adhered to the program as compared with the NE group.

Of the 3 previous studies,[33,46,47] only Wigers et al[33] demonstrated an effect on cardiovascular fitness. In our study, the SBE group improved physical function, a construct that included both self-report and performance-based measures. However, the change in peak $\dot{V}O_2$, an important physiological indicator of cardiorespiratory fitness (mean increase of 0.3 $mL \cdot kg^{-1} \cdot min^{-1}$), was not clinically meaningful. With low levels of cardiovascular fitness at the beginning of the study (peak $\dot{V}O_2$ pretest means of 22.3–23.6 $mL \cdot kg^{-1} \cdot min^{-1}$), we expected to see greater improvements in this variable. Lack of specificity of testing versus training may have contributed to our failure to show changes in peak $\dot{V}O_2$. Because Wigers et al[33] found improvements in fitness using non–intervention-specific cycle ergometer testing, we suspect specificity was not an important factor in our inability to detect an improvement in cardiovascular fitness with the exercise programs.

Table 7.
Means, Standard Deviations, and Ranges for Outcome Variables at Baseline, 8 Weeks, and 16 Weeks by Intervention-for-Efficacy Analysis (N=86)[a]

		Pretest			Midtest			Posttest		
Construct	**Variable**	**NE Group (n=31)**	**SBE Group (n=26)**	**LBE Group (n=29)**	**NE Group (n=31)**	**SBE Group (n=26)**	**LBE Group (n=29)**	**NE Group (n=31)**	**SBE Group (n=26)**	**LBE Group (n=29)**
Physical function	Peak oxygen uptake ($mL \cdot kg^{-1} \cdot min^{-1}$)									
	$\bar{X}$	23.7	22.9	23.8	22.8	23.9	24.3	22.4	23.6	25.3
	SD	4.51	4.59	4.88	3.39	4.94	4.86	4.47	5.26	5.08
	Range	13.9–32.7	14.4–31.1	14.5–36.4	16.8–30.2	15.0–34.8	15.5–38.2	14.5–30.6	11.7–33.5	15.1–39.1
	Duration									
	$\bar{X}$	591	626	657	612	628	662	616	634	706
	SD	157.7	141.4	123.0	103.5	133.9	112.9	116.8	147.2	126.3
	Range	187–830	218–943	364–919	372–791	323–954	415–940	447–886	267–1,000	436–946
	FIQ–impairment									
	$\bar{X}$	3.9	3.0	3.5	3.7	2.8	2.4	3.6	2.5	2.4
	SD	1.91	2.50	1.70	2.19	2.60	1.82	2.27	2.30	2.02
	Range	0.8–8.2	0–7.0	0–7.0	0–7.0	0–7.4	0–7.7	0–9.3	0–7.3	0–7.3
	AIMS2–mobility									
	$\bar{X}$	1.4	2.0	1.8	1.5	1.6	1.3	1.4	1.5	1.3
	SD	1.23	1.80	1.48	1.48	1.62	1.31	1.36	1.81	1.46
	Range	0–4.5	0–5.5	0–5.5	0–6.0	0–5.5	0–5.5	0–5.5	0–6.5	0–6.0
	AIMS2–walking and bending									
	$\bar{X}$	4.1	4.5	4.3	3.7	3.9	3.0	3.6	3.5	3.2
	SD	2.01	1.52	1.92	2.16	2.41	1.73	2.24	1.95	1.90
	Range	0–8.0	2.0–7.5	0.5–8.0	0–7.5	0–8.0	0.5–7.0	0–10.0	0.5–8.0	0.5–8.0
Symptoms	FIQ–fatigue									
	$\bar{X}$	7.8	7.4	7.7	7.5	6.8	6.4	7.4	6.8	6.9
	SD	1.09	1.83	1.35	1.59	1.86	2.18	1.87	2.00	2.17
	Range	5.6–10.0	1.0–9.5)	5.6–9.9	3.5–9.9	3.1–9.5	1.4–9.9	1.2–9.9	1.6–9.2	2.2–9.9
	FIQ–rested									
	$\bar{X}$	7.4	7.2	8.0	7.2	6.3	6.1	7.2	5.9	6.9
	SD	1.86	2.29	1.63	1.86	2.39	2.42	1.74	2.54	2.31
	Range	0.9–9.9	0.2–9.8	4.3–9.9	2.4–9.9	0.3–9.4	1.2–9.5	0.5–9.9	0.2–9.0	1.4–9.9
	FIQ–stiffness									
	$\bar{X}$	7.0	6.0	6.4	7.0	5.7	5.2	6.9	5.2	5.7
	SD	1.91	2.13	1.88	1.56	2.54	2.62	1.64	2.40	2.27
	Range	2.6–9.9	1.8–9.4	2.5–9.2	3.2–9.4	1.4–9.4	1.3–9.5	3.1–9.0	0.7–9.1	1.0–9.9

(continued on next page)

Table 7.
Continued

Construct	Variable	Pretest			Midtest			Posttest		
		NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)	NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)	NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)
Severity	FIQ–total score									
	$\bar{X}$	5.5	5.1	5.5	5.6	4.7	4.3	5.4	4.8	4.7
	SD	1.23	1.52	1.46	1.59	1.77	1.63	1.41	1.85	1.78
	Range	2.5–7.5	1.0–7.9	3.3–9.1	2.1–8.6	1.4–8.3	1.1–8.9	1.2–7.9	1.1–8.0	1.2–8.7
	Physician rating of global severity									
	$\bar{X}$	5.2	5.0	5.1				4.7	3.3	3.9
	SD	1.61	1.78	1.89				1.58	1.24	1.80
	Range	2.5–8.4	2.0–8.9	2.3–8.6				1.4–7.7	1.3–6.1	1.2–8.0
Pain	Pain (VAS)									
	$\bar{X}$	6.2	5.0	5.7	6.1	5.0	4.7	5.6	5.0	4.9
	SD	1.98	2.07	1.99	2.16	2.64	2.27	2.16	2.31	2.59
	Range	1.2–10.0	1.4–8.3	1.6–9.9	1.8–9.9	0.9–9.5	1.0–9.5	0.3–9.9	0.4–7.8	0.7–9.9
	Body distribution									
	$\bar{X}$	21.3	23.3	23.5	19.0	22.5	21.8	21.1	20.5	21.3
	SD	11.64	8.69	6.92	9.93	10.99	10.03	10.93	10.98	11.34
	Range	0–42	8–39	14–38	0–43	4–42	4–39	0–41	6–41	0–42
	Dolorimetry[b]									
	$\bar{X}$	3.8	3.9	3.5				3.7	3.9	3.8
	SD	1.01	0.80	1.01				1.05	1.18	1.19
	Range	1.9–6.5	2.1–5.5	1.7–6.2				2.1–7.3	1.8–7.1	2.0–8.3
	Thumb pressure[b]									
	$\bar{X}$	1.9	1.8	1.9				1.8	1.6	1.7
	SD	0.38	0.34	0.39				0.53	0.49	0.47
	Range	1.0–2.7	1.3–2.4	1.0–2.7				0.6–2.7	0.6–2.6	0.6–2.6
Self-efficacy	Pain									
	$\bar{X}$	51.9	64.6	57.1	47.9	71.5	67.1	48.8	79.2	65.9
	SD	24.49	19.89	25.24	22.47	26.87	26.21	25.81	20.44	24.89
	Range	11.4–94.6	24.4–105.0	11.4–105.0	4.2–105	8.0–112.8	21.8–118.0	1.0–102.4	37.4–113.2	6.2–116.8
	Function									
	$\bar{X}$	66.8	78.4	71.9	63.0	82.4	84.5	68.7	82.7	79.6
	SD	24.55	29.59	27.10	26.14	29.13	22.43	29.58	26.84	25.03
	Range	11.1–106.1	14.0–116.4	15.4–118.0	14.0–115.1	18.3–120.8	24.1–118.0	1.0–114.0	25.6–118.0	19.8–118.0
	Symptoms									
	$\bar{X}$	55.4	68.2	55.7	51.5	72.1	63.6	55.0	76.5	64.9
	SD	19.39	18.15	22.00	19.64	26.36	25.20	24.47	22.43	26.82
	Range	7.5–95.3	38.4–109.9	4.3–103.5	6.8–101.8	22.1–118.0	5.8–114.8	7.5–104.6	38.4–118.0	7.5–113.1

(continued on next page)

Table 7.
Continued

Construct	Variable	Pretest			Midtest			Posttest		
		NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)	NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)	NE Group (n=31)	SBE Group (n=26)	LBE Group (n=29)
Psychological well-being	FIQ–anxiety									
	$\bar{X}$	4.8	4.4	4.3	5.6	3.8	3.1	5.3	4.6	4.0
	SD	2.44	2.89	2.60	2.26	2.99	2.20	2.48	2.76	2.34
	Range	0.0–9.1	0.2–9.4	0.3–8.7	0.5–9.9	0.2–9.6	0.3–8.7	0.0–9.2	0.1–8.9	1.0–9.9
	FIQ–depression									
	$\bar{X}$	4.6	3.8	4.0	5.2	3.7	3.2	5.0	3.9	4.0
	SD	2.34	2.55	2.78	2.37	2.95	2.19	4.47	2.93	2.83
	Range	0.3–9.4	0.2–9.4	0.3–8.7	0.3–9.9	0.0–8.6	0.0–8.0	0.0–9.0	0.0–8.7	0.5–9.9
	AIMS–affect									
	$\bar{X}$	4.6	4.5	4.3	4.5	4.0	3.6	4.5	4.1	3.5
	SD	1.47	1.51	1.30	1.32	1.70	1.59	1.57	1.59	1.62
	Range	1.5–7.8	1.3–7.5	2.0–6.5	2.0–7.8	0.5–7.0	1.3–7.5	1.3–7.3	0.0–6.5	0.0–7.3
	FIQ–feel good									
	$\bar{X}$	6.6	6.8	7.7	6.3	6.6	5.6	6.4	6.3	5.5
	SD	2.57	2.88	2.31	2.83	2.62	2.71	2.76	3.06	2.90
	Range	1.4–10.0	0.0–10.0	4.3–10.0	0.0–10.0	2.9–10.0	0.0–10.0	0.0–10.0	1.4–10.0	0.0–10.0

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, VAS=visual analog scale, FIQ=Fibromyalgia Impact Questionnaire, AIMS2=Arthritis Impact Measurement Scale2.
[b] Measured at pretest and posttest.

Does the lack of improvement in aerobic fitness in 3 of these 4 studies mean that this mode of exercise is not suitable for many individuals with fibromyalgia? Norregaard et al reported that "the majority of subjects could not achieve target heart rate levels"[47(p74)] that corresponded to intensities of 40% to 50% of maximal $\dot{V}O_2$. Neither Wigers et al[33] nor Mengshoel et al[46] reported on adherence. In our study, we used exercise duration over time to reflect training volume and exercise adherence. Exercise adherence was disappointing and likely resulted in the minimal changes in fitness. We were surprised by our difficulties with adherence. We had implemented several strategies that often are recommended to enhance adherence (daily exercise logs[48–51] and telephone calls[52]) and that have been shown to be successful with other populations. We also used strategies commonly recommended to reduce pain and discomfort associated with exercise: (1) minimizing time spent in eccentric contractions, (2) frequently switching prime mover from right to left limb and from one movement to another, (3) including stretches that focused on primary muscle groups used during exercise, and (4) advising participants to decrease exercise intensity if discomfort or fatigue was too great. Although we included these strategies because they, in our opinion, are commonly used, there are no data to suggest that they help adherence. Additional strategies were suggested by group leaders on an individual basis. The results suggest that even with these safeguards in place, this home-based program of low-impact aerobics was not successful in achieving adequate adherence to facilitate a training effect. It is possible that other factors, such as boredom and the isolation of exercising alone at home, also detracted from adherence.

Attrition rates also may be an indicator of the suitability of the mode of exercise. Attrition rates were high in each of the 4 studies: 38% for the SBE group and 29% for the LBE group our study and 20% in the study by Wigers et al,[33] 39% in the study by Mengshoel et al,[46] and 67% in the study by Norregaard et al[47] for corresponding exercise groups. High attrition, poor adherence, and lack of improvements in fitness in our study, as well as in the studies by Mengshoel et al[46] and Norregaard et al,[47] suggest that low-impact aerobics may be an unsuitable mode of exercise for many individuals with fibromyalgia. We caution clinicians to monitor adherence of clients with fibromyalgia performing this mode of exercise and to consider recommending a shift to other modes of aerobic exercise to address adherence problems.

We recognize that our program did not produce the magnitude of improvement in fibromyalgia achieved by researchers studying supervised exercise programs.[13,53] Our training stimulus may have been inadequate because participants found the mode of exercise unsuit-

Table 8.
Summary of *Post Hoc* Comparisons With Bonferroni Corrections for Efficacy Analyses[a]

Construct	*Post Hoc* Between-Group Comparisons With Bonferroni Correction	*Post Hoc* Within-Group Comparisons With Bonferroni Correction
Physical function	NS	LBE (P=.005)
Symptoms	NS	LBE (P=.010)
Disease severity	Midtest LBE vs NE (P=.010) Posttest SBE vs NE (P=.047)	SBE (P=.0006) LBE (P<.0001)
Pain	NS	NE (P=.046)
Self-efficacy	Midtest LBE vs NE (P=.034) Posttest SBE vs NE (P=.001)	SBE (P=.02) LBE (P=.043)
Psychological well-being	Midtest LBE vs NE (P=.041)	LBE (P<.0001)

[a] NE=no exercise, SBE=short bout of exercise, LBE=long bout of exercise, NS=not significant (P>.05).

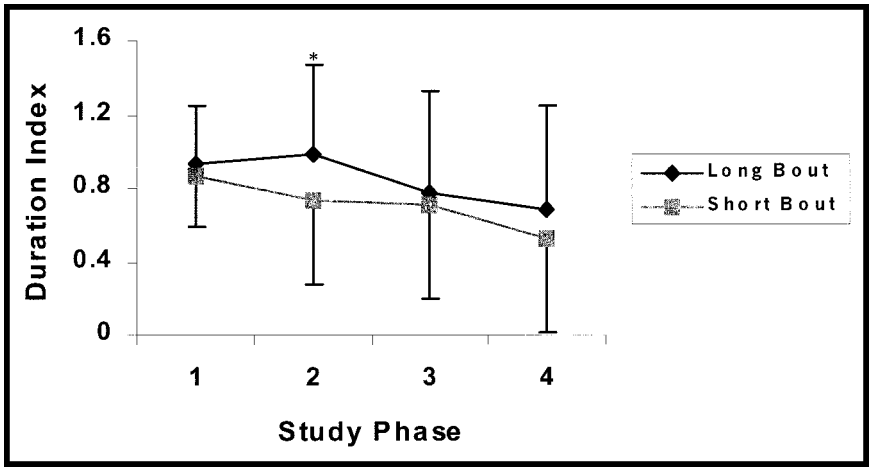

Figure.
Exercise adherence as reflected by exercise duration index values across the four 4-week phases of the 16-week program. Values shown are mean±standard deviation. A participant duration index for each phase was calculated by dividing the sum of the minutes of exercise performed within a phase (as recorded in participant's exercise log) by the minimum number of minutes of exercise recommended for that period. Based on the progression of exercise duration (Tab. 2), duration indexes of participants who performed the greatest number of recommended minutes of exercise would be: 1.0, 1.34, 1.5, and 1.67 for phases 1, 2, 3, and 4, respectively. Asterisk indicates the long bout duration index was greater than the short bout duration index (analysis of variance; df=3,83; P=.048).

able or too difficult or because of the isolation of a home-based program or the monotony of repeating the program without change. Because we did not use external means to monitor exercise duration or intensity, we are unable to verify the participants' reports of duration of exercise performed or whether they were exercising at target intensities. Overreporting of duration or exercising at intensities lower than the target intensities also could have contributed to a suboptimal training stimulus.

In 2 randomized trials,[14,54] researchers examined home-based exercise combined with supervised exercise. Because the effects of the home programs cannot be isolated in either study, direct comparisons of effects cannot be drawn with our study. Nevertheless, we see similarities with our study in the improvement in self-efficacy[14,54] and disease severity.[14]

Researchers in 2 other randomized trials[21,22] used exercise programs that were exclusively home-based. Meyer and Lemley's study of 24-week, low- and high-intensity, home-based progressive walking programs had an attrition rate of 62% and very low participant adherence.[22] Ramsay et al[21] examined 2 formats of delivery of a 12-week circuit aerobics program, comparing a physical therapist-led single start-up session plus home program with a once-weekly physical therapist-led exercise class plus home program. Adherence to the home program was 50% and 72% of recommended exercise in the single-session group and weekly class group, respectively. Thus, we see attrition and adherence problems with 3 different formats of home-based programs. Although we cannot evaluate the effects of the exercise mode separate from those of the delivery method in our study, our results suggest that home-based, videotape-based, low-impact aerobic exercise is not an ideal combination of mode and method for delivery of exercise programs and that individuals with fibromyalgia may benefit to a greater extent from supervised exercise than from home programs.

The fractionation of exercise did not appear to enhance exercise adherence or minimize attrition. Although adherence was lower in the SBE group than in the LBE group only during phase 2 (weeks 4–8), the pattern strongly suggests that 2 short bouts of exercise were more difficult for participants to complete than one single bout of exercise per day. Although SBE attrition was not statistically different from LBE attrition (38% versus 29%), the difference may be clinically meaningful. Fitting 2 short bouts of exercise and associated additional 10 minutes of warm-up and cool-down exercise may have been a disincentive for some participants. When we looked at the participants who were adherent, however, we saw that the SBE group improved at the time of the posttest in both disease severity and self-efficacy relative to the NE

group, whereas the LBE group did not improve. In trying to balance these 2 findings, we feel that there is no clear advantage to distributing home-based, low-impact aerobic exercise over 2 sessions as compared with using one session per day for these individuals with fibromyalgia. Fractionation of exercise may be of value when individuals with fibromyalgia use other modes of exercise.

The assumption that, in order to affect signs and symptoms of fibromyalgia, individuals should follow accepted guidelines for improving cardiorespiratory fitness[55] is challenged by the findings of Mannerkorpi et al.[56] These researchers examined the effects of a program of 6 weekly education sessions in combination with 6 months of supervised, 35-minute, weekly pool exercise classes. Their program was not designed as a training program to improve cardiorespiratory fitness but rather for what the researchers termed "endurance, flexibility, coordination, and relaxation." Participants were encouraged to exercise at their own pace and to modify exercises individually with respect to threshold of pain and fatigue. Mannerkorpi et al[56] reported improvements in FIQ total score, general health, social functioning, quality of life, impairment, anxiety, depression, pain severity, and affective distress. Although we are not able to evaluate how the addition of education (that included information on incorporating physical activity into daily life) to the exercise program affected these results, this study does give pause for thought about the types of exercise prescription that can modify symptoms of fibromyalgia.

In our study, we used ITT analyses to examine the overall benefits of the interventions and the efficacy analysis to examine the effects of the interventions on those participants who adhered to the exercise program. The lack of findings using ITT analyses suggests few overall benefits for women with fibromyalgia. In contrast, through efficacy analyses, the improvements in disease severity, self-efficacy, and psychological well-being at the time of the midtest in the LBE group and in disease severity and self-efficacy at the time of the posttest in the SBE group as compared with the NE group suggest that the programs can have some positive effects on fibromyalgia. We believe that our results should be considered in light of the within-group improvement in 2 constructs for the SBE group and in 5 constructs for the LBE group, suggesting that the intervention had some positive short-term effects.

Although we asked participants not to participate in any other treatment or exercise for fibromyalgia during the study, we did not document such participation. In addition, we did not control for medication taken during the study. Such confounding variables could have contributed to the improvements noted in the NE group and to the variability shown in all groups.

The effect of the selection bias associated with high attrition rates compromises our ability to generalize the results of our study to the population of previously sedentary women with fibromyalgia. We attempted to compensate for this problem by the use of ITT analysis. We attempted to limit Type I errors by grouping the many outcome variables into constructs, by the use of the MANOVAs, and by the subsequent use of Bonferroni adjustments. During the course of the study, we reacted to the high attrition rate by recruiting more subjects for the exercise groups than originally planned and therefore should have maintained sufficient power to find true differences.

Clinical Significance

Our study illustrates a number of practical problems that are highly relevant to clinicians. Participants experienced difficulty in monitoring their levels of exercise intensity. Despite verbal, written, and videotaped instructions and supervised practice at group meetings, many participants reported that they had continual difficulty taking a manual 10-second exercise heart rate. Many participants also reported difficulty using RPE, despite frequent explanations by the group leaders. They said that pain and fatigue interfered with their ability to focus on an "overall feeling of exertion" (as per the standard instructions for using RPE).[23(p77)] Monitoring actual exercise duration and intensity at regular intervals using electronic monitoring devices could address these problems in future studies and in clinical practice. The evidence that fractionation of exercise presented greater challenges to adherence, we believe, also is relevant for clinical practice. Although it is possible that fractionation of other modes of exercise might be more effective, our results suggest that clinicians should carefully consider means of monitoring adherence to fractionated exercise with individuals with fibromyalgia and perhaps with other conditions characterized by chronic pain.

A 16-week program of home-based, videotape-based, low-impact aerobics resulted in small improvements in self-efficacy and disease severity in previously sedentary women aged 20 to 55 years who performed at least two thirds of the prescribed exercise. Adherence problems and smaller improvements suggest that supervised aerobic exercise training using modes such as walking and cycling may be superior for women with fibromyalgia. Fractionation of exercise training provided no advantage in terms of exercise adherence or improvements in fibromyalgia symptoms or physical function.

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Appendix.

Description of Steps for Low-Impact Aerobics Programs[a]

The following is a description of all steps used during warm-up, training, and cool-down segments of the videotaped program, excluding stretches.

Step	Description
Grapevine[b]	Step laterally to R, L foot crosses behind R foot, step laterally with R foot, L foot touches R foot. Reverse.
Grapevine alternatives[b]	(1) Step laterally to R, L foot crosses behind R foot, step laterally with R foot, abduct L hip, lifting foot off floor. Reverse. (2) Step laterally to R, L foot crosses behind R foot, step laterally with R foot, bend L knee up to 90 degrees. Reverse.
March[b]	Step R then L, on the spot. Normal BOS.
March wide	Marching with wide BOS.
Mumbo[b]	From double-leg stance, step forward onto R foot. Shift weight back onto L foot. Step back onto R foot. Shift weight forward onto L foot.
Step touch	Direction of movement can be lateral, forward, or backward. Step onto R foot, step (or slide) L foot to R foot. Reverse.
Step touch variations[b]	(1) Step laterally onto R foot, bring L heel to touch floor in front of R toes. Reverse. (2) Step laterally onto R foot, bring L toes to touch floor in front of R toes. Reverse.
Step touch double variations[b]	Direction of movement can be lateral, forward, or backward. Step touch twice in same direction. Reverse.
Step kick with knee flexion	Step onto R foot, swing NWB L leg into slight hip flexion and lateral (external) rotation, with knee flexion up to 45 degrees. Reverse.
Step kick with knee extension	Step onto R foot, swing NWB L leg into slight hip flexion. Reverse.
Three step[c]	Step back with R foot and then with L foot, step forward onto R foot, swing L through to slight hip and knee flexion. Reverse.
V step[c]	Step forward, widening BOS with R foot and then with L foot, step backward R and then L, narrowing BOS to usual width.
Weight shift A-P	With wide BOS, flex trunk 20 degrees on R hip to lean forward, step forward onto R foot, then extend R hip and shift weight L, touch R heel or toe to floor. Reverse.
Weight shift A-P variation	With wide BOS, flex trunk 20 degrees on R hip to lean forward, step forward onto R foot, flex L knee to 90 degrees. Extend R hip and shift weight L, tap R heel on floor. Reverse.
Weight shift lateral	With wide BOS, shift weight laterally from R to L, lowering COG during the shift. Reverse.
Weight shift lateral variations	(1) With wide BOS, shift weight laterally from R to L, lowering COG during the shift. Once weight has been shifted to L, abduct R hip 20 degrees, lifting toe off floor. Reverse. (2) With wide BOS, shift weight laterally from R to L, lowering COG during the shift. Once weight has been shifted to L, extend R hip slightly, flex L knee to 90 degrees. Reverse.

[a] BOS=base of support, A-P=anterior-posterior, R=right, L=left, NWB=non-weight bearing, COG=center of gravity.
[b] Optional arm movement: bilateral arm adduction in front of body, abduction up to 45 degrees, as comfortable.
[c] Used only during the final one third of the training segment.