Adherence During an Individualized Home Based 12-Week Exercise Program in Women with Fibromyalgia

PATRICIA L. DOBKIN, DEBORAH DA COSTA, MICHAL ABRAHAMOWICZ, MARIA DRITSA, ROXANE DU BERGER, MARY-ANN FITZCHARLES, and ILKA LOWENSTEYN

ABSTRACT. Objective. Treatment recommendations for fibromyalgia (FM) include regular physical exercise. In this prospective study we examined predictors for adherence to stretching and aerobic exercises in women provided with an individualized home based program.

Methods. Thirty-nine women kept exercise diaries for 12 weeks.

Results. For both types of exercise, women who were less physically fit at baseline engaged in more exercise during the program. Yet for stretching, more lower body pain at baseline predicted engaging in less stretching exercise over time, whereas for aerobic exercise, more baseline upper body pain predicted more exercise over time. As time passed, participants with higher baseline physical fitness and/or older age were reducing their aerobic exercise practice at significantly faster rates, as were those women with higher baseline stress.

Conclusion. Given that adequate levels of adherence were limited to about half of the participants for both types of exercise, steps to reduce barriers to exercise (e.g., stress) need to be taken when prescribing exercise in the treatment of FM. (J Rheumatol 2006;33:333–41)

Key Indexing Terms:
EXERCISE ADHERENCE PREDICTORS FIBROMYALGIA

A series of randomized clinical trials (RCT) have evaluated the efficacy of various exercise regimens for patients with fibromyalgia (FM). The types of exercise programs as well as the physical and psychological outcomes assessed in these investigations have varied widely. Martin, *et al*[1] compared the effects of a 6-session supervised group exercise program to a relaxation training group. At posttreatment, the exercise group demonstrated fewer tender points, lower myalgic scores, and better aerobic fitness compared to the relaxation group. Yet of the 60 FM patients enrolled, 22 (37%) dropped out. Wigers, *et al*[2] examined the short-term (posttreatment) and longterm effects of a supervised aerobic exercise program compared to stress management training, or usual medical care, in 60 women with FM. At posttreatment, the exercise group demonstrated less pain, tenderness, and fatigue, and increased global subjective improvement compared to controls. At the 4.5-year followup (which included 44/60 participants), Wigers, *et al*[3] reported that adequate physical activity level and increasing age predicted positive outcomes; however, longterm adherence to exercise was very poor.

Buckelew, *et al*[4] found that a moderate intensity home based exercise intervention resulted in physical (i.e., myalgic score, self-reported pain, physical fitness) and psychological (i.e., self-efficacy) improvements at one and 2 years posttreatment. During the 6-week intervention phase of the study, the majority of patients in the exercise group reported adhering to the home exercise practices — which were reviewed weekly by a physical therapist.

Collectively, the research indicates that some form of physical exercise improves outcomes in FM, albeit there is no consensus regarding the optimal type, intensity, or duration. Yet as Clark, *et al*[5] point out, the program needs to be tailored to the patient's starting fitness levels and symptom severity so that she will not be discouraged or even harmed by the activity. Indeed, the high dropout rates (38% to 87%[5]) during the exercise phase of these studies emphasizes the need to individualize programs that can be more easily integrated into existing lifestyles and systematically examine factors related to exercise adherence. Scrutiny of the various studies of exercise in FM also reveals that adherence has not been adequately measured. Therefore one cannot reach the conclusion that exercise is beneficial for individuals with FM because participants may not have engaged in sufficient exercise to have influenced their health.

From the Department of Medicine, McGill University, Montréal, Québec, Canada.

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P.L. Dobkin, PhD, Associate Professor; D. Da Costa, PhD, Assistant Professor, Faculty of Medicine, Department of Medicine, McGill University and Division of Clinical Epidemiology, McGill University Health Center (MUHC); M. Abrahamowicz, James McGill Professor, Faculty of Medicine, Department of Epidemiology and Biostatistics, Division of Clinical Epidemiology, MUHC; M. Dritsa, MA, Research Associate, PhD Candidate, Université du Québec à Montréal, Division of Clinical Epidemiology, MUHC; R. Du Berger, MSc, Research Associate, Division of Clinical Epidemiology, MUHC; M-A. Fitzcharles, MD, Rheumatologist, Department of Medicine, McGill University; I. Lowensteyn, PhD, Exercise Physiologist, Cardiovascular Health Improvement Program, Montréal.

Address reprint requests to Dr. P.L. Dobkin, Montreal General Hospital, 1650 Cedar Avenue, Montreal, Quebec H3G 1A4. E-mail: patricia.dobkin@mcgill.ca

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Adherence in FM is a relatively neglected topic. Examination of the numerous studies of different interventions (pharmacological, exercise, cognitive-behavioral) reveals that "attrition" from treatment is the variable used most often to approximate adherence[1,6,7]. Almost all the exercise studies reviewed defined adherence as the number of sessions attended[2,8-10]. One exception is found in Huyser, *et al*[11], who conducted a RCT comparing 87 FM patients' self-reported adherence to one of 3 interventions: exercise, biofeedback, and exercise plus biofeedback. Participants completed an in-session questionnaire weekly noting if they practiced their respective interventions 3 or more times per week (yes/no); a summary score for the 6 consecutive weeks was calculated. This approach determined adherence to the program in that patients' behaviors had to meet the requirements stipulated for each group (e.g., if the patient did not practice both biofeedback and exercise, each at least 3 times a week, the score was 0 for that week). Significant group differences indicated the biofeedback group showed the best adherence. The model that best explained 22% of the variance predicting adherence included the following variables: less depression, lower outcome expectancy, and more education, as well as interactions between the following: less self-efficacy and biofeedback group, less self-efficacy and exercise group, and age (older) and exercise group — indicating that in the exercise and biofeedback groups, older patients adhered more to their respective programs. Changes in adherence over time were not examined.

To date the literature pertaining to adherence to treatment of FM provides limited direction in terms of how to best measure this construct and which theoretical models are most appropriate to understand the uptake and maintenance of exercise in this patient population. The Health Belief Model (HBM)[12] proposes that the likelihood an individual will engage in exercise is a function of personal beliefs about threat (i.e., FM symptoms worsening), an assessment of the costs (i.e., barriers such as time, energy), and expected benefits (i.e., outcome expectations such as less pain and fatigue) associated with exercise participation. Huyser, *et al*[11] found little support for this model, although it is possible that both their definition of adherence and failure to examine time effects limited their conclusions. The self-efficacy model has received some support in terms of predicting outcomes in patients with FM[13,14] and exercise in the general population[15]; however, the cross-sectional designs employed and physical activity outcomes studied in FM cannot address the question, "do patients with FM who have high self-efficacy (for pain management, for exercise, etc.) adhere to an exercise program over time?" Anecdotal reports[1,14,16] suggest that patients with FM limit their exercise due to pain and fatigue. We describe uptake for 2 types of exercise prescribed to women with FM by an exercise physiologist who designed an individualized home based program for each participant in the context of a RCT (the main trial results are reported elsewhere[17]). Participants completed weekly logs to measure these 2 exercise modalities during 12 weeks. We aimed to: (1) identify predictors of uptake of stretching and aerobic exercises, and (2) elucidate longitudinal changes in exercise, taking into account participants' baseline characteristics.

MATERIALS AND METHODS

Participants. Women who met American College of Rheumatology criteria for a diagnosis of primary FM were recruited by rheumatologists, through letters inviting patients followed at a hospital rheumatology clinic and community rheumatology practice to participate, or through newspaper advertisements. Exclusion criteria were: (1) concomitant diseases that precluded participation in an exercise program, (2) contraindication to exercise identified by the examining physician, (3) recent change in medication (prior 2 weeks), and (4) regular participation in moderate intensity exercise (i.e., 3.0–6.0 MET, where one MET represents the metabolic activity of an individual at rest: 3.5 ml oxygen consumed per kg body mass per min, or about 1 kcal/kg/h) for at least 30 minutes, ≥ 3 times a week at the time of study entry[18].

Procedures. The study was approved by the McGill University Health Centre ethics committee prior to commencement. Participants were informed about the study procedures and they signed a consent form. They were examined by a physician and subsequently underwent a cardiovascular fitness test. A certified exercise physiologist developed an individualized exercise program for each participant following the fitness test. Next, the self-report questionnaires were explained by the project coordinator with instructions how and when to complete them. Exercise logs were returned by post on a weekly basis, along with selected measures pertaining to FM symptoms and variables hypothesized to be related to adherence to exercise.

Exercise program. During the 12-week training phase, patients met 4 times with the same exercise physiologist. The first visit at baseline was roughly 90 minutes with 30-minute followups scheduled at Weeks 1, 3, and 9 following baseline. The baseline visit included a review of the cardiovascular fitness test results, a brief overview on the benefits of exercise, an individualized exercise prescription, and a supervised exercise training session. Principles of warmup and cool-down along with basic stretching exercises and general exercise precautions were reviewed to minimize the risk of injury.

The exercise prescription was individualized and followed guidelines from the American College of Sports Medicine (ACSM) for developing and maintaining cardiorespiratory fitness[19]. These guidelines suggest individuals perform 60–120 min/week of aerobic exercise within their target heart rate zone (60%–85% of maximal heart rate). The individualized approach allowed for flexibility not only in the intensity and duration but also in the frequency of sessions and the mode of aerobic exercise. Programs were tailored to the individual depending on the severity of FM, accessibility to equipment, time constraints, and enjoyment of various activities. The intensity of the exercise began at 60%–70% of maximal heart rate for all individuals and was gradually increased to as high as 75%–85% of maximal heart rate depending on the participant's adaptation to the exercise. Stretching and strength exercises were also prescribed, with the amount depending on the participants' needs. The followup sessions with the exercise physiologist during the 12-week training phase consisted of providing guidance and support to the women, solving any difficulties, and gradually increasing the intensity of the exercises.

Measures

Exercise logs. Participants completed an exercise log following each exercise session, for the duration of the 12-week program. Each log included the type of exercise performed (stretching, aerobic), frequency, duration, and for the aerobic exercise, intensity using heart rate. A stamped addressed envelope was provided for weekly return of the logs. The project coordinator was vigilant with regard to compliance with the research protocol; if logs were not returned promptly she telephoned participants to encourage continued participation.

Energy expenditure. Energy expenditure was estimated by multiplying the duration of each aerobic activity by the metabolic energy requirement of the activity expressed as a multiple of a MET using the following formula[20]: duration of aerobic activity (min)*METS*(1/60 h). The total weekly energy expenditure (kcal/kg/week) for aerobic activity was then calculated for each of the 12 weeks. MET values were assigned according to the values reported in the Canadian Fitness Survey. We used a conservative approach by assigning the lowest MET value possible for a given activity. For example, according to the Canadian Fitness Survey, a MET value of 3.00 is assigned for light walking, 4.00 for moderate intensity walking, and 5.00 for heavy walking. For the purposes of these analyses a MET value of 3 was assigned to all walking.

Putative Determinants of Exercise

Baseline characteristics. Baseline characteristics included age, education level, work status, income, marital status, and language (English, French). Body weight was assessed to the nearest 0.10 kg with a balance-beam scale. Body mass index (BMI) was calculated by dividing weight (kg) by height squared (m^2).

Cardiovascular fitness. At baseline, all participants performed a physician supervised maximal graded exercise stress test on a treadmill to determine current level of fitness. Procedures used in the fitness screening were based on the ACSM guidelines[21]. Employing a Bruce protocol[22], the test consisted of increasing workloads of roughly 3 MET every 3 minutes until the participant reached volitional exhaustion or any of the ACSM indications for stopping an exercise test[23]. A 12-lead electrocardiogram measured heart rate and rhythm at rest, continuously during the exercise test, and for 5 minutes during recovery. Fitness was evaluated by time on test and maximal MET capacity.

Physician assessment. A rheumatologist examined the participants, assessed tender points, and documented duration of symptoms and time since diagnosis of FM. A physician global assessment of disease activity using a 100 mm visual analog scale (VAS)[24] was obtained at baseline. End descriptors were 0 = no activity to 100 = very high activity. A review of 24 RCT in FM found the physician global assessment as the most likely outcome to respond to treatment[25].

Self-reported FM symptoms. Pain intensity was recorded at baseline and weekly during the 12-week training phase. Participants were asked to indicate their pain intensity over the past week on 100 mm VAS[24] in 6 areas: neck and shoulders, chest, upper/lower back, arms, buttocks, and legs. End descriptors were 0 = no pain to 100 = severe pain, higher values reflecting more pain. The scores were summed across body sites to yield total upper and total lower body pain intensity scores. VAS to assess fatigue, disturbed sleep, and global illness severity were also included. This measure was developed for this study in order to examine the effect of symptoms on exercise engagement in subsequent weeks.

Weekly Stress Inventory (WSI)[26]. The WSI is a self-report instrument assessing the frequency and stressfulness of minor stressors that respondents have experienced over the past week. This 87-item questionnaire asks respondents to indicate for each item whether the event occurred in the past week, and to rate the perceived stressfulness of the experienced event on a 7-point scale (1 = occurred but was not stressful, to 7 = extremely stressful). The WSI yields a Total WSI-Impact derived by summing the perceived stress ratings. It was designed to avoid problems such as items being confounded with psychological symptoms of distress, insensitivity to subtle fluctuations in stress levels, and contamination from retrospective reports. It has good psychometric properties, as described in a cardiac rehabilitation patient population[27].

Self-efficacy. Self-efficacy was measured using the Arthritis Self-Efficacy Scale[28]. Two of the 3 subscales were used in this study: (1) self-efficacy for pain management; and (2) self-efficacy for other (FM) symptoms. The construct and concurrent validity of this scale have been reported[29]. This measure was administered to all patients at baseline and posttreatment; the term "arthritis" was replaced with "fibromyalgia."

Depressive symptoms. The depression subscale of the Symptom Checklist 90-R (SCL-90-R) was used to assess depressive symptoms at baseline. This widely used measure has been validated with medical patients[30].

Exercise Beliefs Questionnaire. The Exercise Beliefs Questionnaire developed by Gecht, *et al*[31] for arthritis patients (replaced here with "fibromyalgia") includes 20 items addressing the following aspects: self-efficacy for exercise, barriers to exercise, benefits of exercise, and effect of exercise on FM. This scale was administered at baseline and posttreatment.

Statistical analyses. Means and standard deviations and proportions were employed to describe the baseline distributions of, respectively, quantitative and categorical participant characteristics. To assess the predictors of exercise participation, and to explore the determinants of longitudinal changes in 2 types of exercise modalities, 2 classes of multivariable statistical models were employed. Both types of models used the consecutive weekly values of the outcome, as measured by the total time of exercise in a given week (or total weekly energy expenditure) as a quantitative repeated-measures dependent variable. Generalized estimating equations (GEE) extension of the multiple linear regression, with autoregressive order 1 AR(1) covariate structure, was used to account for the correlation between repeated measures on the same subject[32]. Separate models were estimated for stretching and aerobic exercise, as well as for energy expenditure.

The first model focused on baseline predictors of between-participants differences in the average amount of exercise across weekly measurements. Lower and upper body pain, stress (WSS), and fatigue were considered potential predictors of exercise based on *a priori* knowledge, and all were included in the multivariable GEE models, regardless of their statistical significance. Other putative predictors of adherence, i.e., baseline cardiovascular fitness (MET), physician assessment (MD-VAS), depression (SCL-90-R), age, working status (fulltime, part-time), self-efficacy for pain, exercise barriers, and beliefs regarding benefits, were selected into the final model through the backward elimination procedure with $p > 0.15$ criterion for elimination. In addition, the model included the effect of time, represented by subsequent weeks, to assess if there was a systematic change in the exercise levels. Thus, comparison of exercise levels of different participants was adjusted for possible differences in the timing of their assessments, due to occasionally missing values or early attrition. Finally, to determine if temporal changes in exercise depended on participants' baseline characteristics, we investigated 2-way interactions between selected characteristics and time. We first forced all baseline variables, as well as time, into the model, and then used stepwise selection with $p < 0.10$ and $p > 0.15$ criteria for entry and elimination, respectively, to identify statistically significant effects among all pairwise interactions involving time.

The second model examined if stress, pain, and fatigue in a given week had systematic effects on the change in exercise levels in the next week. First, we relied on backward elimination of statistically nonsignificant ($p > 0.15$) variables from the initial model that included baseline measures of cardiovascular fitness (MET) and physician-rated disease severity (MD-VAS), as well as the time-dependent variables representing the recent values of lower and upper body pain, stress (WSS), fatigue, and weekly minutes of exercise, all measured in the previous week. Thus, pain, fatigue, and stress in a previous week were employed as predictors of exercise in the current week, while adjusting for selected baseline characteristics and for recent exercise levels. The latter adjustment implied that we focused on short-term change in exercise among participants with the same level of exercise in the previous week. We hypothesized that among participants with the same exercise level during a given week, those who experienced more stress, pain, and/or fatigue would reduce their next week's performance.

Finally, to avoid problems with separating the effects of these possibly intercorrelated measures of stress, pain, and fatigue, we estimated separate GEE models, each including only one of the 3 measures, adjusted only for the previous-week levels of exercise participation and baseline characteristics. Unless indicated otherwise, 0.05 significance level was used for all tests. All GEE analyses were performed using the Genmod procedure in the SAS statistical package.

RESULTS

Participants. Thirty-nine women were randomized to the home based exercise program (results of the trial are reported elsewhere[17]). At the end of 12 weeks, 33 (84.6%) women were still participating in the study protocol. The average age was 49.2 years (SD 8.7). At study entry, the mean symptom duration was 10.5 years (SD 8.4). The mean time since diagnosis of FM was 3.8 years (SD 4.5). The average BMI was 28.0 (SD 2.0). The average MET achieved on the cardiovascular stress test was 8.9 (SD 2). Table 1 summarizes the distribution of sociodemographic, disease related, and fitness variables at study entry.

Adherence over 12 weeks. While we could not study "adherence" precisely because there was no set criterion with which to compare the results (the program varied across participants and over time), there was a "global standard" to reach, over the 12-week training phase — at least 60 minutes of stretching per week and at least 120 minutes of aerobic exercise per week. Figures 1 and 2 show the percentages of women stretching and performing aerobic exercises within the respective global standards. About half the participants were adherent, throughout the program, for stretching exercises, but fewer (about 40%) were adherent to aerobic exercises. For both types of exercise, there was an initial increase in duration, followed by a slight decline.

Figure 3 shows the energy expenditure for aerobic activities, by week, in mean MET values across the participants. There is no systematic trend to increase or decrease.

Table 1. Participant characteristics at baseline.

	Mean (SD)	%
Age, yrs	49.2 (8.7)	
Education, yrs	14.0 (2.8)	
Marital status		
Single	9	23.1
Married/cohabiting	25	64.1
Divorced/separated	4	10.3
Widowed	1	2.6
Work status		
Not working	16	41
Working fulltime	14	35.9
Working part-time	9	23.1
FM duration, yrs	10.5 (8.4)	
Time since diagnosis, yrs	3.8 (4.5)	
Physician global assessment*	49.3 (18.3)	
Tender points	12.8 (4.6)	
BMI	28.0 (6.0)	
MET at baseline**	8.9 (2.0)	

* Visual analog scale 0–100. Higher scores indicate greater disease activity. **Higher MET indicate better cardiovascular fitness. MET: metabolic activity of an individual at rest; see Materials and Methods.

Effects of baseline characteristics. The upper part of Table 2 shows the main effects of baseline characteristics selected by backward elimination on average-over-time exercise participation separately for each type of exercise. Positive parameter estimates indicate that higher values of a given characteristic are associated with increased participation, whereas negative estimates indicate the opposite. The lower part of the table identifies those 2-way interactions between individual baseline characteristics and time that were selected using stepwise selection.

Duration of stretching exercise. Only higher lower-body pain and fitness levels were statistically significantly associated ($p < 0.05$) with lower average-over-time adherence to stretching during the 12-week followup (left part of Table 2).

A trend toward reducing participation in stretching over time did not reach statistical significance ($p = 0.17$). No statistically significant 2-way interactions between time and participant's baseline characteristics were found for stretching, which suggested that the steady level of participation over time was common across different subgroups.

Duration of aerobic exercise. The middle part of Table 2 shows that participants with more upper body pain had higher average-over-time aerobic exercise participation ($p < 0.01$). Higher baseline fitness and older age both ($p < 0.0001$) were associated with less aerobic participation.

Over the 12 weeks, participants with higher baseline fitness ($p < 0.01$), older age ($p < 0.0001$), and higher baseline stress ($p = 0.02$) reduced their aerobic exercise participation at significantly faster rates, as indicated by statistical significance of respective interactions (Table 2). Once these interactions were taken into account, older participants with higher baseline fitness levels and/or higher stress were not significantly different from others with respect to the aerobic exercise participation at the beginning of the program (data not shown). In contrast, upper body pain was not associated with the rate of change in aerobic participation ($p = 0.69$ for interaction; data not shown), but participants with more pain continued to engage in more aerobic exercise across the 12-week program ($p < 0.01$), even after adjustment for the 3 interactions.

Energy expenditure. The right part of Table 2 shows that participants with higher upper-body pain had higher average-over-time energy expenditure ($p < 0.01$), whereas higher fitness levels and older age were associated with less energy expenditure ($p = 0.0001$). Associations between higher fatigue and depression and lower energy expenditure were both marginally nonsignificant ($p < 0.10$).

The overall changes in energy expenditure over time were nonsignificant, but there were 3 statistically significant interactions between time and baseline characteristics (Table 2). Results indicated that the detrimental effects of

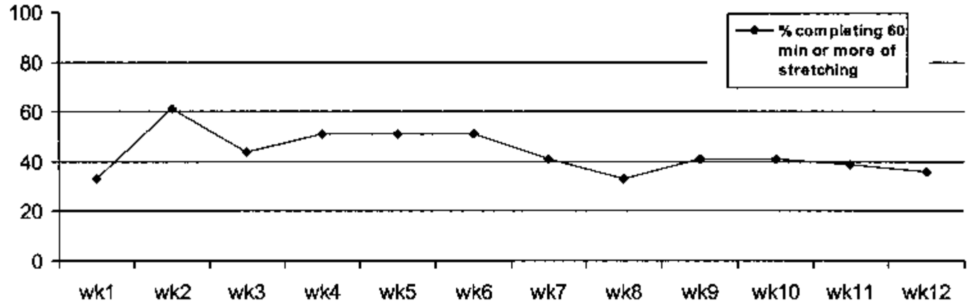

Figure 1. Percentage of participants engaging in stretching exercises > 60 minutes per week.

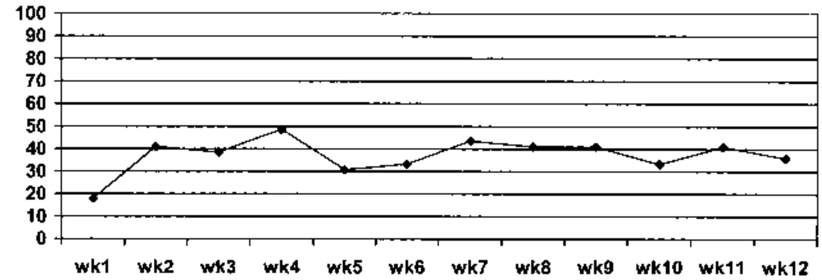

Figure 2. Percentage of participants engaging in ≥ 120 minutes aerobic activity by week.

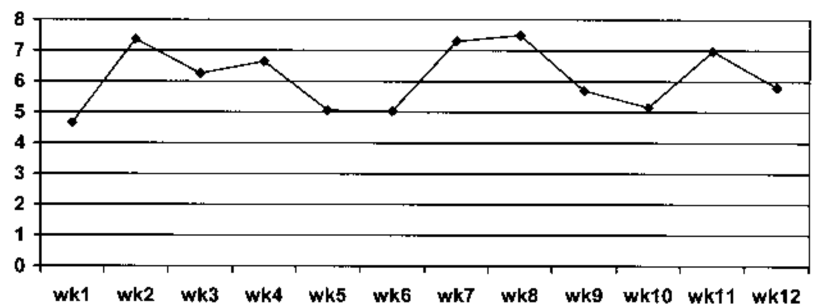

Figure 3. Energy expenditure (kcal/kg/wk) for aerobic activities by week.

older age and higher baseline fitness on energy expenditure were not evident at the beginning of the program, but increased with its increasing duration. Participants with higher baseline fitness ($p < 0.01$) and/or older age ($p < 0.01$) were reducing their weekly energy expenditure at significantly faster rates than the less fit or younger subjects. In addition, those with higher baseline stress also decreased their energy expended at a higher rate ($p = 0.02$ for the stress by time interaction). Whereas the level of upper body pain was not associated with the rate of change in energy expenditure ($p = 0.62$ for the interaction with time), participants with more pain had significantly higher energy expenditure levels across time ($p < 0.01$), even when adjusted for the 3 interactions.

Short-term effect of recent stress, pain, and fatigue on changes in weekly exercise participation. Table 3 presents the results of multivariable models for predicting changes in weekly exercise participation. As expected, in all analyses exercise participation in a current week was a highly statistically significant predictor of the subsequent exercise participation ($p < 0.0001$). However, the association between exercise levels in the 2 consecutive weeks was stronger for stretching than for either aerobics or energy expenditure (Table 3). These relationships were not materially affected by the inclusion or exclusion of other putative predictors in the GEE models (data not shown).

Moreover, the baseline fitness had a consistently negative association with exercise in a subsequent week, even when adjusted for the current week's exercise and other characteristics listed in Table 3. This finding is consistent with the finding that participants with higher baseline fitness decrease their exercise participation over time at a faster rate (Table 2). However, the negative adjusted effect of baseline fitness was statistically significant for only stretching and aerobic exercises ($p = 0.04$ with all *a priori* selected covariates), while being marginally nonsignificant for energy expenditure ($p = 0.11$).

Table 2. Results of final multivariable models for predicting average-over-time exercise levels.

Predictor at Baseline	SD (baseline)	Units	Outcome (exercise type): Duration, min: Stretching Parameter Estimate	95% CI	Aerobic Parameter Estimate	95% CI	Energy Expenditure: Aerobic Parameter Estimate	95% CI
Main effects[a]								
FM lower body pain[b]	25.75	1 SD	–12.02*	–23.25, –0.79	–2.77	–20.58, 15.04	–4.43	–63.73, 54.87
FM upper body pain[b]	15.49	1 SD	0.93	–8.91, 10.76	22.78**	7.13, 38.42	77.70**	24.60, 130.79
Fatigue[b]	17.48	1 SD	–16.17*	–28.47, –3.87	–17.58*	–39.36, 4.21	–66.21*	–141.80, 9.38
WSS[b]	61.69	1 SD	–1.31	–11.25, 8.63	–4.41	–23.25, 14.43	–18.70	–80.74, 43.33
MET	1.98	1 SD	–26.49**	–43.36, –9.61	–37.55***	–53.38, 21.71	–125.60***	–180.63, –70.57
Depression	0.72	1 SD			–17.42	–36.77, 1.93	–54.47	–118.50, 9.57
Age		1 yr			–4.21***	–5.75, 2.67	–15.75***	–20.82, –10.68
Time[b]		1 wk	–1.35	–3.27, 0.57	–2.14	–7.18, 2.91	–4.65	–21.25, 11.95
Interaction terms[c]								
Time by WSS	61.69	Week × SD			–3.19*	–5.83, –0.55	–11.33*	–20.52, –2.14
Time by MET	1.98	Week × SD			–4.15**	–6.70, –1.59	–14.53**	–22.79, –6.26
Time by age		Week × year			–0.72***	–1.07, –0.37	–2.50***	–3.66, –1.33

[a] Models selected by backward elimination with exit criteria $p > 0.15$. The full model included MD-VAS, working status (full, part-time), self-efficacy for pain, exercise barriers, and benefits. [b] Variable was forced into all models regardless of its statistical significance; variable was not selected into the corresponding model. [c] Interaction terms are those selected by stepwise selection while forcing all main effect variables into the model (full model). WSS: Weekly Stress Score; MET: metabolic activity of an individual at rest. * $0.01 \le p < 0.05$; ** $0.001 \le p < 0.01$; *** $p < 0.001$.

Table 3. Results of multivariable models for predicting changes in weekly exercise participation[a].

Predictor	SD (baseline)	Units	Outcome (exercise type in subsequent week): Duration, min: Stretching Parameter Estimate	95% CI	Aerobic Parameter Estimate	95% CI	Energy Expenditure: Aerobic Parameter Estimate	95% CI
Current week								
Stretching		Min	0.85***	0.76, 0.94				
Aerobic exercise		Min			0.48***	0.37, 0.60		
Aerobic energy expenditure (EE)		EE					0.48***	0.36, 0.60
FM lower body pain	25.75	1 SD	0.28	–3.88, 4.45	4.57	–10.69, 19.83	7.68	–45.95, 61.02
FM upper body pain	15.49	1 SD	–1.18	–3.85, 1.49	–1.76	–15.61, 12.08	2.87	–44.95, 50.43
Fatigue	17.48	1 SD	0.23	–1.92, 2.38	–2.70	–10.40, 5.00	–10.15	–36.28, 15.84
WSS	61.69	1 SD	0.07	–2.73, 2.88	–1.81	–16.55, 12.93	–10.89	–59.33, 37.30
Baseline								
MD-VAS	18.33	1 SD	–0.70	–3.21, 1.82	–1.31	–10.54, 7.93	–6.13	–36.65, 24.24
MET	1.98	1 SD	–3.86**	–7.46, –0.26	–8.95**	–17.70, –0.21	–25.42*	–56.63, 5.62

[a] Full models to undergo backward elimination with exit criteria $p > 0.15$. The final model results in the selection of an exercise type and MET whose parameter estimates and confidence limits are close to those of the full model. WSS: Weekly Stress Score; MD-VAS: physician rating by visual analog scale; MET: metabolic activity of an individual at rest. * $0.05 \le p < 0.15$; ** $0.01 \le p < 0.05$; *** $p < 0.0001$.

In contrast, the current week levels of stress, fatigue, and lower or upper body pain all consistently failed to improve the prediction of the change in exercise participation in the subsequent week (Table 3). Specifically, for all 3 outcomes, the backward elimination procedure always excluded the previous week's measures of fatigue, upper and lower body pain, and stress levels. Moreover, the p values for pain, fatigue, and stress were always > 0.30, regardless of the type of exercise. Such consistently high p values strongly suggest that the statistical nonsignificance of the effects of fatigue, pain, and stress reflects an absence of any material effect of these variables on short-term changes in levels of exercise participation, rather than insufficient statistical power. Finally, the confidence interval around the estimated effects of fatigue, pain, and stress are reasonably narrow, mostly due to a large number of the repeated weekly observations contributed by each participant and to a consistent lack of the effects. For example, the 95% CI for the adjusted effect of increasing fatigue by 1 standard deviation, typically considered a large change in the predictor[33], on the next week's duration of stretching exercise is –1.9 to +2.4, corresponding to 1.9 minutes' reduction and 2.4 minutes' increase, respectively, in the total weekly duration of exercise. Thus, even the lower limit of the 95% CI corresponds to only a very small, clinically irrelevant, reduction in weekly exercise duration. Similarly, the 95% CI for the effects of change in other measures (pain or stress) and/or on the other types of exercise consistently exclude any clinically important changes in adherence (Table 3).

DISCUSSION

We studied the uptake of exercise in women with FM and sought to identify determinants of adhering to this lifestyle change over a 12-week period. While there were relatively few participants (N = 39), data collection was intensive (weekly), allowing us to examine variables that influenced 2 types of exercise modalities: stretching and aerobic. We planned this study with the Health Belief Model in mind, but also collected data on self-efficacy, as the arthritis literature has found support for this construct for other outcomes[13,14]. We employed statistical models that used the consecutive weekly values of the total minutes of exercise in a given week as a quantitative repeated-measures dependent variable, and relied on GEE extension of the multiple linear regression to account for the correlation between repeated measures in the same participant.

As it was possible that predictors of the 2 types of exercise modalities could differ, we examined them separately. Indeed, some predictors varied across behaviors, whereas others did not. In both types of exercise, women who were less physically fit at baseline engaged in more exercise. Yet for stretching, more lower body pain at baseline predicted engaging in less stretching exercise over time, whereas for aerobic exercise, higher baseline upper body pain predicted more participation over time. Older age was associated with less participation in aerobic exercise, but not stretching. Significant interaction effects were found only for aerobic exercise. As time passed, participants with higher baseline physical fitness and/or older age were reducing their participation in aerobic exercise at significantly faster rates, as did women with higher baseline stress. On the other hand, once these interactions were taken into account, older participants with higher baseline physical fitness and/or higher stress were not significantly different from others with respect to the initial exercise participation.

Similar to other reports for patients with arthritis[34], for both types of exercise, adequate levels of adherence were limited to about half of the participants. Thus, even for an individualized program that took into account participant characteristics at the initiation of the exercise program, many had problems meeting global standards of performance. This decreased participation was not due to FM related symptoms in the previous week, as illustrated in the second series of our analyses (Table 3).

The findings from these latter analyses may come as a surprise to healthcare providers working with FM patients, as it is commonly believed that they fail to begin or continue to exercise due to pain and fatigue. It is possible that given the graded exercise program prescribed, participants in this study did not experience more pain and fatigue when they exercised. If this is true, then our program was consistent with guidelines presented by Clark, *et al*[5]. There was, nonetheless, a gradual decline in stretching and aerobic exercises over time and this was more evident in participants who were more physically fit at baseline. Perhaps these individuals perceived less threat and therefore did less, consistent with one aspect of the Health Belief Model[12].

The finding that high baseline stress predicted less aerobic exercise over time is consistent with other work examining the relationship between stress and exercise. A recent study in the general population found that higher baseline stress emerged as a significant predictor of lower exercise adherence at a 2-year followup[35]. Stetson and colleagues[36], using methods similar to ours (diary and WSI), prospectively examined the relationship between ongoing minor stressful events and weekly aerobic exercise in normal-weight women, for 8 weeks. Results showed that during high-stress weeks, participants exercised fewer days, omitted more planned exercise sessions, and were less satisfied with their exercise. The most common type of stressor was "time pressure." In this situation, stress can be viewed as a barrier to engagement in exercise, another aspect of the Health Belief Model.

This study is the first to closely examine both uptake and persistence in exercise behaviors in women with FM. Its strengths lie in the intensity of the data collection and the analytic techniques that enabled examining changes over time and predictors of these changes. Nonetheless, these findings could be called into question because they are based on self-report[37]. Self-report can be erroneous if the participant wants to be viewed positively by others, or if there is recall bias. We addressed these 2 potential problems by having the project coordinator (not the exercise physiologist) keep track of the daily logs; recall bias was minimized by having participants complete the logs after each exercise session and return the form weekly. Another problem that may have occurred is that self-monitoring may have influenced the amount of participation in exercise itself. Logically, one would expect an increase in reported exercise if this were the case; here, there was a decrease in both types of exercise over time. Thus, it does not appear that this investigation was compromised by relying on self-report for data collection[38].

While providing novel data, this study is, nonetheless, limited by a potential selection bias. Clearly, only women who were willing to start an exercise program entered the trial. Thus, they are not representative of all patients with FM. Also, no men participated in the study, further restricting generalizability of the results. The majority were French-Canadians (as is the case in Québec, Canada); we do not know if their behaviors differ from those of other ethnic groups.

What are the clinical implications of these findings? First, an individual's fitness level at the beginning of the program predicts further engagement. Those who are less fit are more likely to continue to exercise. Those who are more fit may reach a plateau in a shorter time span, and thus lose motivation for exercise. Consequently, when prescribing exercise, patients may be informed that even if they are physically fit they need to stick with the program. Second, weekly levels of stress, pain, and fatigue did not influence the following week's level of exercise activity. This can be discussed with patients who fear beginning exercise because they hold the false belief that it will make their symptoms worse. Indeed, Vlaeyen and Linton[39] note that the Fear-Avoidance Model can explain negative outcomes in patients with musculoskeletal chronic pain, because fear of pain leads to avoidance of behaviors (such as exercise), which, in turn, leads to deconditioning and disability. It should be emphasized that exercise is only one means of improving FM patients' condition; when done in conjunction with other forms of treatment (e.g., medications, cognitive-behavioral therapy) patients are most likely to benefit[40].

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