Aerobic Fitness Effects in Fibromyalgia

VALÉRIA VALIM, LEDA OLIVEIRA, ALINA SUDA, LUCIANA SILVA, MARCOS de ASSIS, TURRIBIO BARROS NETO, DANIEL FELDMAN, and JAMIL NATOUR

ABSTRACT. ***Objective.*** To compare 2 exercise modalities, aerobic fitness training and stretching exercises, in patients with fibromyalgia (FM) in relation to function, pain, quality of life, depression, and anxiety, and to correlate the cardiorespiratory fitness gain with symptom improvement.

Methods. Seventy-six women with FM between 18 and 60 years old were randomized to either an aerobic program or stretching program, for 20 weeks. They were evaluated at the beginning of the program and after 10 and 20 weeks in relation to the improvement of aerobic fitness, flexibility, function, Fibromyalgia Impact Questionnaire (FIQ), Short-form Health Survey (SF-36), and depression and anxiety levels. Ventilatory anaerobic threshold (VT) and maximum oxygen uptake (VO_{2max}) were determined by expired gas analyses.

Results. Aerobic exercise was superior to stretching in relation to $VO_{2\ max}$, VT, function, depression, pain, and the emotional aspects and mental health domains of SF-36. Patients in the stretching group showed no improvement in depression, "role emotional," and "mental health." No association was noted between improvement in aerobic fitness as measured by VT and the improvement of pain, function, or scores in FIQ and SF-36.

Conclusion. Our results confirm that aerobic exercise is beneficial to patients with FM, but the cardiorespiratory fitness gain is not related to improvement of FM symptoms. (J Rheumatol 2003;30:1060–9)

Key Indexing Terms:
FIBROMYALGIA AEROBIC FITNESS EXERCISE FLEXIBILITY
STRETCHING ANAEROBIC THRESHOLD OXYGEN UPTAKE

Fibromyalgia (FM) is a chronic painful condition characterized by generalized pain, sleep disturbance, and fatigue[1,2]. Changes in pain central modulation and increase in peripheral nociception are relevant physiopathology[3-9]. Patients with FM have decreased physical fitness and this is an important factor in FM pathogenesis[10-12].

There are some controlled studies evaluating exercises for the management of FM. Most of these were dedicated to aerobic fitness, either combined with other modalities or individually[13-26]. Among these studies, 4 evaluated aerobic conditioning individually[14,17,18,21], 2 evaluated stretching individually[14,22], and 3 studied combined exercises[16,19,20]. However, among them all, only 3 studies lasted more than 10 weeks[14,17,22]. No trials have been done measuring aerobic fitness directly by a spiroergometric test and the aerobic threshold, the most appropriate cardiorespiratory fitness measure for patients with FM[13]. Few of these studies showed the benefit of exercise for quality of life compared to controls[21,23]. The results of these studies showed little statistically meaningful improvement in comparisons between groups, so, in spite of consensus that exercise is beneficial in the treatment of FM, the existing evidence is not consistent. None of the studies encompassed, at the same time, a prescription according to the criteria of the American College of Sports Medicine (ACSM)[27], that is, a longer duration, a quality of life evaluation, and a cardiorespiratory fitness evaluation.

No study has been carried out to determine which aspect of quality of life is more influenced by each exercise modality. It seems that all exercise modalities have beneficial effects on FM, although the aerobic conditioning appears to be superior. It is possible that the exercise modality influences different aspects of quality of life, because exercise presents different stimuli to peripheral and central modulation of pain and to production of neurotransmitters. Prescribing an exercise program for patients with FM is empirical. The ideal training intensity has not yet been established. Considering that the intensity of the aerobic training correlates with higher gains in cardiorespiratory fitness, knowing whether cardiorespiratory fitness gain is correlated with symptom improvement would be useful in the prescription of exercise.

We compared 2 exercise modalities, aerobic fitness training and stretching exercises, in patients with FM in relation to pain, quality of life, depression, and anxiety.

From the Division of Rheumatology, Department of Medicine and Sports and Physical Medical Center, São Paulo Federal University, São Paulo, Brazil.

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V. Valim, MD, Division of Rheumatology; L.M. Oliveira; A.L. Suda; L.E. Silva, Physiotherapists, Rheumatology Rehabilitation Section, Divison of Rheumatology; M.R. de Assis, MD, Division of Rheumatology; T.L. Barros Neto, PhD, Head, Sports and Physical Medical Center; D. Feldman, MD, Professor, Division of Rheumatology; J. Natour, MD, Head, Rheumatology Rehabilitation Section, Division of Rheumatology.

Address reprint requests to Dr. J. Natour, Division of Rheumatology, Universidade Federal de São Paulo, Rua Botucatu, 740, 04023-900 São Paulo, Brazil. E-mail: jnatour@reumato.epm.br

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Secondary objectives were to determine which specific aspects of quality of life could be improved by these 2 exercise modalities, and to correlate the cardiorespiratory fitness gain with symptom improvement.

MATERIALS AND METHODS

Seventy-six sedentary women from the rheumatology outpatient clinic of the Federal University of São Paulo, between 18 and 60 years old, who met the American College of Rheumatology ACR 90 criteria for classification of FM[1] were randomized into 2 exercise modalities: aerobic exercise (AE) and stretching exercise (SE). Each group was supervised by a trained physiotherapist. Patients with cardiorespiratory diseases limiting their physical activities, neurological disorders, body mass index > 35, hypothyroidism, or other rheumatic diseases were excluded. All patients were newly diagnosed and had never had previous treatment. Only acetaminophen was allowed as rescue medication during the trial. Women without regular physical training for the last 3 months were classified as sedentary.

The AE group underwent a walking program monitored with frequency meters and supervised by a physiotherapist 3 times a week, of 45 min duration, for 20 weeks. The walking speed (training load) was determined by the training heart rate. Training heart rate was defined as the load beat immediately preceding the one in which the anaerobic threshold occurred. Each training session was preceded by a warmup period, where patients were instructed to walk freely and slowly for 5 to 10 min. After each session the patients were placed in a circle and made rhythmic movements, to promote cooling off, for 5 min.

The SE program consisted of 3 sessions a week of 45 min duration each and included 17 exercises using both muscles and joints in a general way, including face, cervical, trunk, and extremities. It lasted for the same 20 weeks. Each maximum position was sustained for 30 s. The exercises were chosen to provide for overall flexibility, without increasing heart rate. These are described below.

Stretching exercises. (A) Standing with the knees a little apart (shoulder width) and bent in order to protect the spinal column: (1) Pull the head sideways, trying to touch the ear against the shoulders on both sides (right and left). (2) Turn the head sideways, looking right and left. (3) Clasp the hands and pull the head down, looking at the floor. (4) Clasp the hands, pulling forward and lowering the head. (5) Clasp the hands, pushing up and looking forward. (6) Clasp the hands behind the back and push the hand back. (7) Clasp the hands behind the head and open the elbows. (8) Stretch the arms forward, pulling the hand with palm turned in and the fingers down. (9) Stretch one of the arms forward, pulling the hand with the palm turned out and the fingers up. (10) Place the hands on the opposite shoulder, with bent elbows, and push it back as if embracing and turning the face to the same side as the arm being stretched.

(B) Sitting on the floor: (11) Bend the knees and move them apart, resting the soles of the feet against each other ("Buds position"). Put a club between the feet, hold the club with both hands and climb to the end of the club and push it forward. (12) Do the same placing the club in front of the knees. Do this on both sides. (13) Stretch a leg and bend up the other, crossing it over, with the feet then resting on the floor. In this way, twist the trunk, turning to the side of the bent leg.

(C) Standing up: (14) Move the legs apart, placing one forward and the other backward, with both feet turned forward. Bend the front knee and stretch the back leg without removing the heel support. (15) Move the legs sideways, with both feet turned forward. Bend the knees to the side. Do this on both sides. (16) On a step, rest on one of the feet with the knees well bent. (17) Holding the wall, bend one of the knees against it and pull it back with one of the hands.

The patients were evaluated by a blinded investigator at the beginning and after 10 and 20 weeks (end of exercise program) in relation to the improvement of aerobic fitness, flexibility, pain, function, quality of life, depression, and anxiety levels. Cardiorespiratory fitness was evaluated by oxygen uptake at the ventilatory anaerobic threshold (VT) and by the maximum oxygen uptake (VO_{2max}) measured directly by the spiroergometric test. Considering that patients with FM do not achieve a maximum effort, the VT was the main measure of aerobic fitness[12,13].

All the patients underwent an increasing load protocol on the treadmill[28], with a maximum duration of 13 min. Analysis of expired gas was by a computerized metabolic system, Vista Mini-CPX (Vacumed).

We studied the first anaerobic threshold determined by using the slope point on the curve of the oxygen ventilatory equivalent (VE/VO_2). The heart rate at the end of each stage and the maximum heart rate were monitored through a frequency meter and recorded.

Flexibility was evaluated by the sit-and-reach test, which was done before each spiroergometric test[29].

The influence of FM on quality of life was assessed with a specific questionnaire, the Fibromyalgia Impact Questionnaire (FIQ), and a generic questionnaire, the Medical Outcome Study Short-Form Health Survey (SF-36), administered by a single interviewer. The SF-36 has been validated for a Brazilian population and it has 8 domains: physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health[30-32]. These 8 domains were condensed into 2 components: Physical Component Summary (PCS) and Mental Component Summary (MCS)[33]. The brief, 10 item FIQ was developed and validated for populations with FM[34].

Assessment of psychological status was done using the Beck Depression Inventory[16,35] and the Trace-State Anxiety Inventory[25,36]. The number of tender points and pain score were evaluated to compare our results with others'. The pain score was calculated by quantifying the pain presented during palpation of the tender point, using the following scale: 0 = no pain, 1 = expression of pain, 2 = verbal exclamation, 3 = movement to withdraw. The pain score could vary from 0 to 54[37].

Statistics. The visual analog scale (VAS) for pain was the primary measure used to determine sample size. Statistical significance was set at 5% and power of 80%. These led to 76 patients to be randomized to allow for a 20% dropout rate.

The main hypothesis was that aerobic exercise is a better treatment than stretching exercise to improve pain and quality of life. In all measures tested we considered the null hypothesis (H0) as being the point of equality between groups tested and H1 the point of difference. Bilateral tests were carried out adopting a 5% level of significance.

At first Levene's nonparametric test was used to check if the variances in both groups were the same, a basic presupposition for the application of Student's t test.

To compare the effects of the 2 exercise modalities repeated measures analysis of variance (ANOVA) was carried out. The factor "period" (before, at the midpoint at 10 weeks, and after 20 weeks) within the individual, the factor "situation" (aerobic exercise and stretching) between individuals, and the interactions between them for each one of the variables were studied. In variables where we found significance in the interaction between the factors time and situation, we carried out other ANOVA considering only the periods before–middle and middle–after, to determine the possible average differences.

Multiple linear regression and chi-square tests were used to analyze the association between the amount of physical fitness improvement and outcome measures. Only for the chi-square test we categorized the results which were defined as significant if they achieved an increase of 15% in the physical evaluation measures (spiroergometric and sit-and-reach test) and 30% of improvement in clinical improvement measures (questionnaires on quality of life, mood, pain, tender points, and pain score).

For analyses we used the general linear model, repeated measures option, in the Statistical Package for the Social Sciences, release 8.0.

RESULTS

Sixty women completed the 20 weeks of the study and were

included in the statistical analysis. Ten individuals in the stretching group and 6 in the aerobic group left the study. This difference was not significant (chi-square 1.27, p = 0.26). Dropouts in the aerobic exercise group left the study before 10 weeks, whereas in the flexibility group the dropouts occurred randomly during the 20 weeks. In the aerobic exercise program, 3 patients interrupted the treatment because they returned to their jobs, one dropped out without explanation, and 2 did not attend most of the training sessions. In the stretching program, half the patients did not adhere to the program, 4 dropped out without explanation, and one went on vacation. Comparison between individuals who remained in the program and the dropouts showed that those who left the study presented a worse pain score and better vitality and mental health indexes (Table 1).

Baseline values showed no differences between the groups, except for the Beck Depression Inventory score (t = –2.925, p = 0.005). Demographic baseline values for the aerobic exercise and flexibility groups were as follows, respectively: age 47 ± 10 vs 44 ± 11 years (p = 0.335); weight 63 ± 8 vs 68 ± 6 kg (p = 0.150); and body mass index 26 ± 3 vs 28 ± 6 kg/m^2 (p = 0.186). There was no statistically significant difference between the groups for the variables weight (F test = 0.226, p = 0.637) and body mass index (F test = 0.185, p = 0.699) after training.

The aerobic exercise group presented a significant improvement in VO_{2max} and VT in relation to the flexibility group, indicating that the walking intervention was efficient. Also, there were statistically significant differences between the groups for heart rate at VT and test duration. Both groups improved significantly in the sit-and-reach test. Although the difference between the means was higher in the stretching group than in the aerobic group, it was not significant (Table 2). Sixty percent of the individuals in the aerobic exercise group and 33% of those in the stretching group improved over 15% in VO_{2max} (p = 0.044). The anaerobic threshold increased in 60% of the patients in the aerobic group, and 11% of those in the stretching group presented an increase ≥ 15% (p = 0.000).

Aerobic exercise was superior to stretching exercise in the total FIQ score, in the role emotional, mental health domains, and the Mental Component Summary of the SF-36. Also, the Beck Depression Inventory, visual analog scale (VAS) for pain, pain score, and number of tender points improved significantly (Tables 3 and 4). Although ANOVA did not show any difference between groups for STAI score, 34% of the patients in the aerobic exercise group showed improvement, while only 4% of the stretching group achieved some improvement (p = 0.014, Fisher test). Analysis of the results over time (weeks 10 and 20) showed that patients first gained physical fitness, and only after that did the clinical symptoms improve (Table 5).

Patients in the aerobic training group were already improved by 10 weeks and continued to get better until the 20th week. In contrast, those in the stretching program appeared to improve less and to stabilize around the 10th week (Figure 1). The stretching group did not improve in the mental health or role emotional domains and the Mental Component Summary of the SF-36 or the Beck Depression Inventory after 20 weeks of training (Table 5).

Although aerobic exercise was superior to stretching exercise for pain, quality of life, and psychological status,

Table 1. Means ± SD and p value of characteristics of patients that did and that did not complete the trial.

	Concluded, N = 60	Dropouts, N = 16	p
Age, yrs	46.05 ± 9.82	47.57 ± 12.85	0.64
VO_{2max}, ml/kg/min	25.05 ± 4.92	23.89 ± 3.31	0.40
VT, ml/kg/min	16.32 ± 3.14	15.27 ± 2.35	0.24
FIQ	5.11 ± 1.53	4.56 ± 1.65	0.30
VAS	5.90 ± 1.99	5.80 ± 1.81	0.87
SF-36			
Physical functioning	55.1 ± 20.3	58.3 ± 19.4	0.64
Role physical	23.3 ± 32.1	30 ± 40.3	0.5
Bodily pain	34.9 ± 16.2	38.8 ± 17.3	0.42
Role emotional	40.4 ± 44	42.2 ± 46.2	0.89
Vitality	31.18 ± 18.95	48.46 ± 24.36	0.007*
Mental health	42.83 ±19.19	56 ± 23.26	0.03*
Social functioning	53.52 ± 26.53	57.54 ± 34.5	0.64
General health	49.71 ± 23.67	57.54 ± 30.45	0.31
Beck Depression Inventory	19.51 ± 8.12	15.4 ± 11.87	0.53
STAI — state	47.31 ± 9.11	44.53 ± 8.13	0.15
STAI — trace	53.85 ± 10.42	48.57 ± 10.56	0.12
Tender points	15.86 ± 2.55	15.33 ± 3.37	0.13
Pain score	23.5 ± 8.57	29.86 ± 15.71	0.03*

* p ≤ 0.05, t test. FIQ: Fibromyalgia Impact Questionnaire, SF36: Short-Form Healthy Survey, VAS: visual analog scale, VT: ventilatory anaerobic threshold, STAI: State-Trace Anxiety Inventory.

Table 2. Means ± SD, F test, and p value of comparisons between aerobic exercise (AE) and stretching exercise (SE) groups in the spiroergometric test and sit and reach evaluation.

	Aerobic, N = 32	Stretching, N = 28	F Test	p, AE vs SE
$VO_{2max,}$ ml/kg/min				
T0	25.40 ± 5.39	24.67 ± 4.42	5.232[a]	0.026*
T1	27.41 ± 5.93	25.65 ± 6.47	0.539[b]	0.466
T2	28.57 ± 4.71	25.21 ± 4.59	5.322[c]	0.025*
VT, ml/kg/min				
T0	15.97 ± 3.23	16.72 ± 3.72	38.588[a]	0.000**
T1	18.33 ± 4.04	16.23 ± 3.72	9.975[b]	0.003*
T2	19.13 ± 3.50	15.13 ± 2.72	9.209[c]	0.004*
Rest heart rate, bpm				
T0	86 ± 13	85.14 ± 12.03	0.851[a]	0.361
T1	76 ± 8	81.68 ± 12.10		
T2	79 ± 11	81.23 ± 8.49		
Maximum heart rate, bpm				
T0	168 ± 13	158 ± 17	0.091[a]	0.765
T1	168 ± 11	163 ± 16		
T2	171 ± 12	163 ± 14		
Heart rate at VT, bpm				
T0	133 ± 11	131 ± 15	14.573[a]	0.000**
T1	141 ± 10	134 ± 16		
T2	147 ± 12	132 ± 16		
Test duration, min				
T0	8.52 ± 1.27	8.54 ± 1.97	9.393[a]	0.003*
T1	10.97 ± 3.61	9.46 ± 1.6		
T2	11.40 ± 3.21	9.67 ± 1.41		
Sit and reach, cm				
T0	15.85 ± 9.05	18.89 ± 7.96	0.551[a]	0.466
T1	18.64 ± 9.72	23.43 ± 8.57		
T2	19.59 ± 10	27.04 ± 7.96		

[a] ANOVA comparison between groups in the period. [b] T0 vs T1, [c] T1 vs T2, by ANOVA. * $p \leq 0.05$ ** $p \leq 0.001$. T0: beginning, T1: 10 weeks, T2: 20 weeks. VT: ventilatory anaerobic threshold, VO_{2max}: maximum oxygen uptake.

no association was noted between gain in cardiorespiratory fitness as measured by VT and the improvement of pain, FIQ, SF-36, or Beck scores, using the chi-square test or linear regression analysis (Table 6).

DISCUSSION

Physical exercise is an inexpensive intervention that can not only modify the pain threshold in FM, but can also promote health in other aspects[38]. Aerobic exercises can benefit chronic painful conditions through several mechanisms, such as increasing peripheral levels of ß-endorphins[39,40], influencing the monoamino-serotoninergic system[41], promoting a decrease in sympathetic activity[42], improving sleep[43], and improving psychological status[44,45].

Quality of life in patients with FM has been studied in previous exercise trials. Most were of short duration[16,19,21-23,25,26]. Only 2 tested the influence of exercise on quality of life compared to a control group[21,23]. Our results revealed that, in comparison to a control group, aerobic exercise can improve the total FIQ score and the role emotional and mental health domains and Physical Component Summary of the SF-36, which are good indicators of health status and quality of life, and also a good measure of the effect of FM in activities of daily living.

Our results and those of McCain, *et al*[14] suggest that stretching should not be considered as a placebo intervention, because patients in this group also benefit from it. But in particular, the emotional and psychological aspects were not modified through stretching. When physical and mental component summaries were studied, we observed clearly that aerobic fitness is superior to stretching to improve the mental component. One hypothesis to justify this could be that aerobic fitness can induce neurohumoral changes necessary to improve depression/anxiety, and stretching does not. As both groups had to come 3 times a week and spend the same time with a physiotherapist, a placebo effect is not a viable explanation for this difference.

Pain is the central symptom of FM. Previous studies reported some improvement in the pain VAS[18,20], while others did not[14,19]. We noted that both groups improved their pain, but the aerobic exercise was better than the stretching program. Patients in the stretching group had some

Table 3. Means ± SD, F test, and p value of comparisons between aerobic exercise (AE) and stretching exercise (SE) in the Fibromyalgia Impact Questionnaire, visual analog scale, Beck Depression Inventory, State-Trace Anxiety Inventory, tender points, and pain score.

	Aerobic, N = 32	Stretching, N = 28	F Test	p, AE vs SE
Total FIQ				
T0	5.30 ± 1.50	4.89 ± 1.65	14.932[a]	0.012*
T1	3.73 ± 2.22	4.09 ± 1.83	1.574[b]	0.215
T2	3.04 ± 1.92	4.03 ± 1.55	4.063[c]	0.049*
VAS				
T0	6.19 ± 1.64	6 ± 2.1	5.698[a]	0.021*
T1	5.00 ± 2.71	4.7 ± 2.5	0.086[b]	0.771
T2	3.42 ± 2.50	4.6 ± 2.18	0.660[c]	0.013*
BDI				
T0	19.90 ± 7.88	13.89 ± 7.89	8.617[a]	0.006*
T1	14.00 ± 7.89	13.56 ± 10.26	6.039[b]	0.017*
T2	11.41 ± 6.24	12.15 ± 8.40	0.086[c]	0.771
STAI — state				
T0	46.52 ± 8.34	50.07 ± 8.93	0.038[a]	0.847
T1	45.57 ± 9.17	47.40 ± 8.61		
T2	40.21 ± 9.00	45.04 ± 9.34		
STAI — trace				
T0	54.23 ± 10.36	51.96 ± 9.03	0.827[a]	0.368
T1	48.25 ± 10.25	49.64 ± 11.29		
T2	46.50 ± 11.06	46.69 ± 12.44		
Tender points				
T0	16 ± 2	15 ± 2	4.236[a]	0.046*
T1	14 ± 4	16 ± 3	4.422[b]	0.041*
T2	11 ± 6	14 ± 4	0.492[c]	0.487
Pain score				
T0	23.57 ± 8.8	23.43 ± 8.49	5.171[a]	0.028*
T1	21.29 ± 8.73	27.63 ± 10.09	5.197[b]	0.027*
T2	15.25 ± 9.67	23.68 ± 10.30	0.015[c]	0.902

[a] ANOVA comparison between groups in the period. [b] T0 vs T1, [c] T1 vs T2, by ANOVA, where there were statistically significant differences between groups in the period. * $p \leq 0.05$ ** $p \leq 0.001$. T0: beginning, T1: 10 weeks, T2: 20 weeks. FIQ: Fibromyalgia Impact Questionnaire, VAS: visual analog scale, BDI: Beck Depression Inventory, STAI: State-Trace Anxiety Inventory.

improvement by week 10, without any further amelioration of symptoms up to week 20. The aerobic group presented progressive improvement curves at 10 and 20 weeks. These patients had already achieved a significantly higher VT at week 10. However, VO_{2max} was only different between the 2 groups by week 20. A possible explanation for this dissociation could be that in order to obtain maximum oxygen uptake, the patient must exert a maximal effort, so they need to feel better to do it.

Sixty-six percent of patients gained more than 15% of VO_{2max}. On the other hand, 33% of the patients in the stretching program gained cardiorespiratory fitness, probably because they had some kind of improvement in pain and because they had adapted themselves to the test, thus making a maximum effort. The previous studies on FM exercises did not measure VO_{2max} and VT.

Both groups improved flexibility; therefore there was no difference between groups in relation to this point. The improvement in flexibility in the aerobic fitness group must be related to the improvement in the symptoms.

There were more dropouts in the stretching group, although the difference was not significant. The individuals who abandoned the treatment were those who initially presented a worse pain score, were emotionally better, and presented more vitality. Therefore, individuals with more pain can have lower tolerance to effort and those determined to be emotionally worse may have felt more supported in a program in which they were taken care of.

Surprisingly, we did not observe any association between the amount of improvement in cardiorespiratory fitness and improvement of pain measures, mental status, and quality of life. In other words, it is not necessary to gain cardiorespiratory fitness, as measured by VO_{2max} or VT, to improve self-efficacy. There have been reports that exercise below the level recommended for cardiovascular training is enough to decrease the risk of degenerative and metabolic

Table 4. Means ± SD, F Test, and p value of comparisons between aerobic exercise (AE) and stretching exercise (SE) in the Short-form Health Survey domains (SF-36).

	Aerobic, N = 32, Raw Scale	Stretching, N = 28, Raw Scale	F Test	p, AE vs SE
Physical functioning				
T0	56.77 ± 20.23	53.20 ± 20.15	0.023[a]	0.880
T1	72.50 ± 19.08	68.80 ± 17.64		
T2	74.31 ± 17.36	68.27 ± 21.49		
Role physical				
T0	27.42 ± 38.38	18.75 ± 22.18	0.154[a]	0.697
T1	51.79 ± 40.78	56.00 ± 34.82		
T2	56.03 ± 38.18	41.35 ± 39.33		
Bodily pain				
T0	37.10 ± 14.65	32.75 ± 17.46	0.001[a]	0.981
T1	53.89 ± 16.88	42.92 ± 20.54		
T2	60.03 ± 19.13	51.92 ± 20.43		
Role emotional				
T0	35.55 ± 43.71	44.04 ± 44.49	6.280[a]	0.016*
T1	61.90 ± 42.27	50.66 ± 40.96	2.060[b]	0.157
T2	76.19 ± 42.41	48.71 ± 40.4	0.851[c]	0.361
Vitality				
T0	31.61 ± 19.93	31.25 ± 16.98	2.418[a]	0.127
T1	53.04 ± 23.66	43.20 ± 21.74		
T2	40.65 ± 20.21	42.31 ± 22.28		
Mental health				
T0	40.65 ± 20.21	45.43 ± 18.26	9.283[a]	0.004*
T1	59.43 ± 21.10	52.00 ± 19.46	3.216[b]	0.079
T2	63.31 ± 15.79	51.38 ± 19.29	0.581[c]	0.450
Role social				
T0	53.79 ± 28.02	50.62 ± 27.16	0.059[a]	0.809
T1	70.98 ± 23.82	66.50 ± 25.44		
T2	79.31 ± 21.20	72.59 ± 20.92		
General health				
T0	49.13 ± 26.96	50.50 ± 21.02	1.042[a]	0.313
T1	61.20 ± 28.56	57.38 ± 26.90		
T2	69.07 ± 23.96	60.92 ± 23.56		
Physical component summary				
T0	37.86 ± 9.53	34.73 ± 7.32	0.796[a]	0.377
T1	43.39 ± 7.80	42.55 ± 7.53		
T2	45.37 ± 8.73	42.82 ± 9.48		
Mental component summary				
T0	34.18 ± 11.36	37.20 ± 9.51	8.603[a]	0.005*
T1	44.13 ± 12.10	39.87 ± 11.40		
T2	48.00 ± 10.23	40.09 ± 11.28		

[a] ANOVA comparison between groups in the period. [b] T0 vs T1, [c] T1 vs T2, by ANOVA, where there were statistically significant differences between groups in the period. * $p \leq 0.05$ ** $p \leq 0.001$. T0: beginning, T1: 10 weeks, T2: 20 weeks. FIQ: Fibromyalgia Impact Questionnaire, VAS: visual analog scale, BDI: Beck Depression Inventory, STAI: State-Trace Anxiety Inventory.

diseases, but it is not enough to increase VO_{2max} [46-50]. Physical activity can improve physical fitness and health condition, but the improvement in health is probably secondary to biological changes different from those responsible for the gain of physical fitness[51].

The main finding of this study is that aerobic exercise improves the quality of life when compared to another control physical intervention (stretching) in patients with FM. Although this conclusion is a consensus, other studies in the literature were not methodologically appropriate or were unable to show differences statistically. Our secondary observations perhaps may have relevance in the practice of these prescribed exercises: (1) aerobic conditioning improved all aspects of quality of life we studied, but was superior to stretching mainly in the emotional, psychological, and mental health aspects; (2) the clinical improvement provided by conditioning happens with a 10 week training period, but is greater with a 20 week period; and (3) no indi-

Table 5. Exact p values for intragroup analysis between beginning (T0), 10 weeks (T1), and 20 weeks (T2).

	T0 vs T1		T0 vs T2		T1 vs T2	
	Aerobic	Stretching	Aerobic	Stretching	Aerobic	Stretching
Total FIQ	0.001**	0.002*	0.000**	0.001**	0.003*	0.762
VAS	0.051*	0.01*	0.000**	0.000**	0.001*	0.632
BDI	0.002*	0.569	0.000**	0.06	0.063	0.084
STAI — state	0.750	0.105	0.017*	0.01*	0.003*	0.206
STAI — trace	0.021*	0.103	0.003*	0.040*	0.131	0.247
Pain score	0.104	0.136	0.02*	0.984	0.006*	0.014*
Tender points	0.02*	0.648	0.001**	0.307	0.009*	0.045*
SF36						
Physical functioning	0.000**	0.000**	0.002*	0.002*	0.840	0.931
Role physical	0.007*	0.000**	0.000**	0.01*	0.473	0.185
Vitality	0.000**	0.004*	0.000**	0.005*	0.301	0.741
Mental health	0.000**	0.159	0.000**	0.094	0.226	0.969
General health	0.007*	0.063	0.000**	0.013*	0.026*	0.213
Bodily pain	0.000**	0.000**	0.000**	0.000**	0.147	0.015*
Role emotional	0.028*	0.028*	0.000**	0.644	0.337	0.831
Social functioning	0.007*	0.013*	0.000**	0.001**	0.086	0.303

* $p \leq 0.05$ ** $p \leq 0.001$, paired t test. T0: beginning, T1: 10 weeks, T2: 20 weeks. FIQ: Fibromyalgia Impact Questionnaire, VAS: visual analog scale, BDI: Beck Depression Inventory, STAI: State-Trace Anxiety Inventory, SF36: Short-Form Health Survey.

Table 6. Chi-square and p value of association between quality of life and fitness improvement evaluated by oxygen uptake at anaerobic threshold (VT).

	Total, N = 60		Stretching, N = 28		Aerobic, N = 32	
	Chi-square	p	Chi-square	p	Chi-square	p
Total FIQ	3.175	0.090	0.048	1.000	1.348	0.440
VAS	2.808	0.154	Fisher	0.231	Fisher	1.000
SF36						
Physical functioning	0.212	0.779	Fisher	0.096	0.738	0.460
Role physical	1.054	0.305	Fisher	0.565	Fisher	1.000
Bodily pain	0.010	1.000	Fisher	1.000	Fisher	1.000
Role emotional	0.033	1.000	Fisher	1.000	Fisher	0.683
Vitality	0.587	0.561	Fisher	0.543	Fisher	0.692
Mental health	0.663	0.571	Fisher	1.000	Fisher	1.000
Social functioning	1.150	0.375	Fisher	0.230	Fisher	0.668
General health	0.288	0.776	Fisher	0.230	2.673	0.137
Physical component summary	0.110	0.740	Fisher	1.000	Fisher	0.057
Mental component summary	3.178	0.075	Fisher	0.504	Fisher	1.000
BDI	3.605	0.087	Fisher	0.543	2.673	0.137
STAI — State	Fisher	0.071	Fisher	1.000	Fisher	0.419
STAI — Trace	Fisher	0.732	Fisher	0.521	Fisher	1.000
Pain score	0.019	1.000	Fisher	1.000	0.540	0.692
Tender points	0.221	0.758	Fisher	0.395	1.418	0.428

BDI: Beck Depression Inventory, FIQ: Fibromyalgia Impact Questionnaire, SF36: Short-Form Health Survey, VAS: visual analog scale, VT: ventilatory anaerobic threshold, STAI: State-Trace Anxiety Inventory.

vidual association was found between the delta of cardiorespiratory fitness gain and improvement of quality of life, suggesting that training intensity would not be the determinant for this improvement.

We found no correlation between improving cardiorespiratory fitness and improving quality of life. Considering that high intensity training is related to less adherence to the program[52], and that the gain in both VO_{2max} and VT is not related to improvement of FM symptoms, we suggest that aerobic fitness exercises in patients with FM should be of low to moderate intensity. Other studies are necessary to understand the mechanisms through which exercise improves the symptoms of FM and whether the intensity of training interferes with improvement of the symptoms in FM.

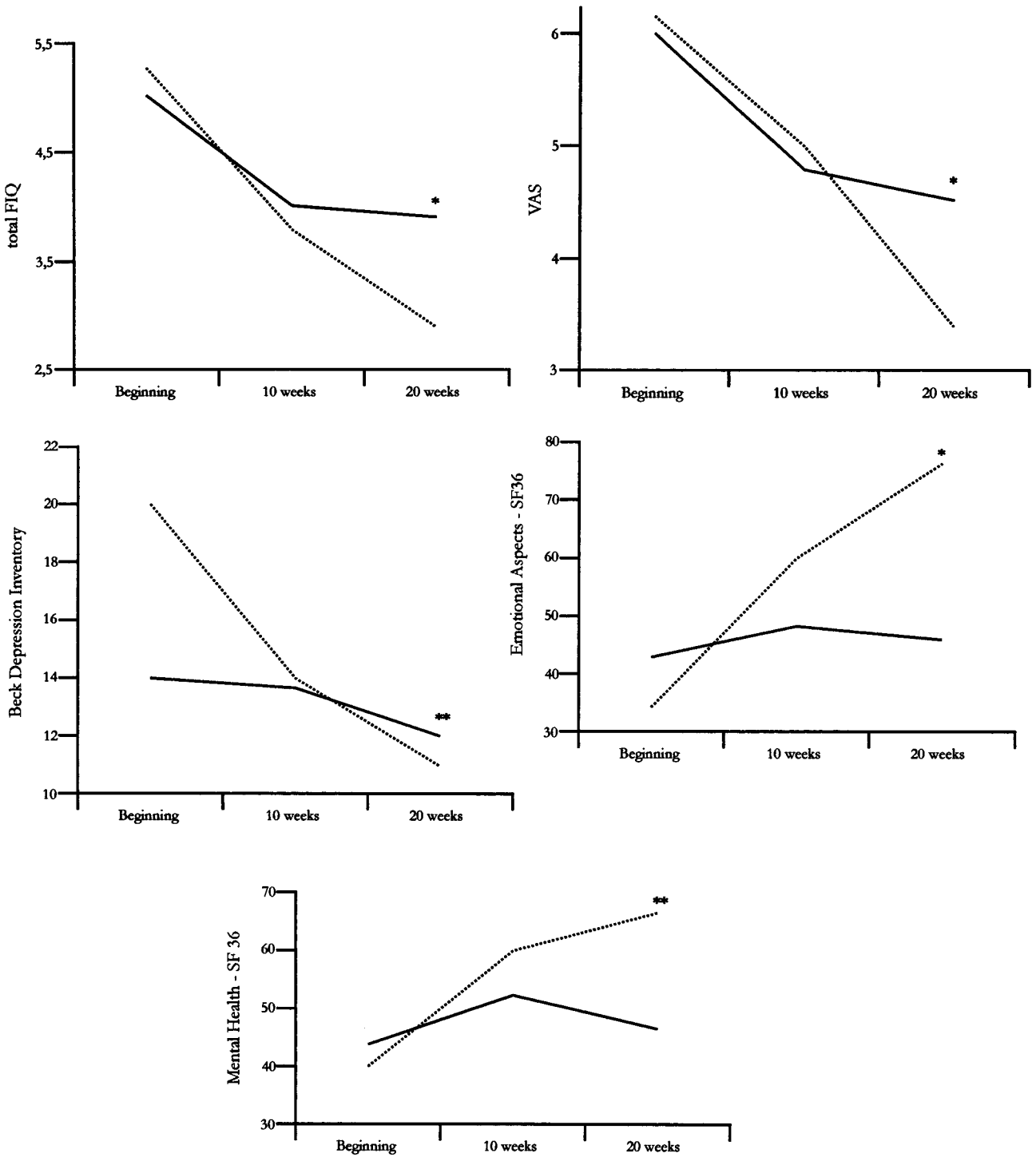

Figure 1. Measures indicating aerobic exercise was better than stretching exercise. For all panels: broken line = aerobic exercise group; solid line = stretching exercise group. FIQ: Fibromyalgia Impact Questionnaire, SF 36: Short-Form Health Survey, VAS: visual analog scale for pain. *p ≤ 0.05, **p ≤ 0.001.

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