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ORIGINAL ARTICLE

Effect of aquatic respiratory exercise-based program in patients with fibromyalgia

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Abstract

Objective: This study assessed the effects of an aquatic respiratory exercise-based program in patients with fibromyalgia (FMS).

Methods: Forty women, aged between 20 and 60 years, were randomly assigned into two groups of 20 patients: the aquatic respiratory exercise-based program (ARG) and the control group (CTL). The ARG group performed the exercise program for 1 h, four times a week, for 4 weeks which included: (i) warming-up; (ii) respiratory exercises, consisting of five different breathing patterns, along with upper, lower limbs and trunk movements (45 min); and (iii) relaxation exercises. Both groups were included in supervised recreational activities of 1 h, once a week, for 4 weeks. Questionnaires were applied before and after intervention to assess quality of life and functional capacity (SF-36, Fibromyalgia Impact Questionnaire [FIQ]), anxiety (Hamilton Anxiety Scale [HAS]), and quality of sleep (Pittsburg Sleep Quality Index [PSQI]). Number of tender points and pain (Visual Analogue Scale [VAS]) were also evaluated.

Results: At baseline there was no difference between the two groups, including number of tender points and questionnaire responses. After intervention, the ARG group, compared with the CTL group, showed improvement in SF-36 scores (physical functioning $P = 0.001$, bodily pain $P = 0.001$, vitality $P = 0.009$, social functioning $P = 0.001$, emotional role $P = 0.001$), in FIQ (total score $P = 0.049$, work missed $P = 0.036$, fatigue $P = 0.013$, morning tiredness $P = 0.007$) plus in VAS-pain ($P = 0.029$), VAS-dyspnea ($P = 0.04$), anxiety (HAS $P = 0.005$) and quality of sleep (PSQI $P = 0.004$).

Conclusions: The short-term aquatic respiratory exercise-based program improved pain, quality of life, functional capacity, anxiety and quality of sleep in patients with FMS and may be a relevant addition to the treatment of these patients.

Key words: exercise therapy, fibromyalgia, health status, pain, quality of life, sleep.

INTRODUCTION

Fibromyalgia syndrome (FMS) is a chronic rheumatic condition with unknown aetiology and unclear pathogenesis. It is characterized by pain, sleep disturbances and fatigue. Patients also relate headaches, morning stiffness, irritable bowel syndrome, paresthesia, dyspnea and Raynaud's syndrome.[1] Psychological symptoms are also observed, including mood disturbance, anxiety, depression, phobia and panic syndrome[2,3] contributing to the complex disease symptomatology[4] as well as to the reduced quality of life and impaired functional capacity observed in these patients.

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Due to an incomplete understanding of the disease mechanisms, in addition to multiple, non-visible symptoms typical of FMS[5] plus absence of validated objective markers of the disease,[1] a patient's treatment is a challenging task. Widely varied therapeutic approaches ranging from physical therapy, massage, acupuncture[1] aerobic and strengthening exercises[6] to cognitive-behavioural therapies[1,7,8] have been employed with variably recognized efficacy. Aquatic exercise benefits have been claimed in fibromyalgic patients[9–15] as a result of its capacity to induce pain relief and muscular relaxation, promoting a pleasant stimulus for exercise compliance. Associated with water-controlled temperature, aquatic exercises produce analgesia on nerve endings by increasing pain threshold[16] and by decreasing pain sensation due to water hydrostatic pressure on the body surface,[17] facilitating regular exercise, particularly in patients with FMS.

On the other hand, respiratory exercises are routinely used to improve pulmonary performance that can be assessed by measuring volume, capacity, and peak flow of the lungs. However, respiratory exercises can also be used to promote relaxation, depending on how they are applied.[18] Such use is particularly important in the Eastern world, where, according to traditional customs, several techniques and modalities of exercise emphasize the importance of breath, Yoga being one of them. Yoga commonly involves slow and deep breathing, almost to the vital capacity, followed by short apneas at the end of inspiration and expiration.[19] The cardiac autonomic responses are described as attenuated,[20] with neuromuscular activity diminished, and proprioceptive input to the hypothalamus reduced. This reduction decreases the activation of the central nervous system, decreasing the excitability of the cerebral cortex.[21] Hence, it is considered that the relaxation achieved by these exercises involves both physiological and mental aspects.[21]

Therefore, this study proposes a protocol of an aquatic respiratory exercise-based program, emphasizing the importance of respiratory awareness during all movements, as a therapeutic alternative for patients with fibromyalgia. The efficacy of this unique approach is assessed through four self-reported questionnaires.

MATERIALS AND METHODS

Patients

Forty women with FMS (1990 American College of Rheumatology [ARC] criteria)[22] were enrolled in the study, after informed consent and compliance of inclusion and exclusion criteria. Exclusion criteria were the presence of musculoskeletal, respiratory, neurological, cardiovascular, skin diseases or hydrophobia reported by the patients or identified by an examining physician precluding participation in an aquatic exercise program. Patients enrolled in any other regular exercise activity or who were institutionalized were also excluded. Inclusion criteria comprised time availability, means of transportation, and acceptance of the training routine (no more than 25% of absences anticipated).

Procedures and randomization

After the baseline evaluation, patients were randomly assigned to the aquatic respiratory exercise-based program (ARG, $n = 20$) or to the control (CTL, $n = 20$) group by drawing lots. Each patient chose a sealed envelope containing the group designation. After completing the program, patients of both groups were evaluated by an assessor blinded to the groups' assignments and the questionnaires were applied. Thirty-five patients aged 20–60 years (mean = 46.06 ± 9.15) finished the study. In the ARG group, one patient was excluded due to vascular disease and another due to missing more than 25% of the activities. In the CTL, one patient moved from the city, and two others were not available for the post-treatment assessment.

Both groups, ARG and CTL, were included in supervised recreational activities, for 1 h, once a week, for 4 weeks. These activities involved no exercises, no health related issues and consisted of recreational card games, music and general interest seminars.

Description of the exercise program

The ARG group performed the aquatic respiratory exercise-based program, in a 32°C heated pool, 1.05 m deep, for 1 h in the evening, four times a week, for 4 weeks. Patients were asked to keep their shoulders in the water. The aquatic respiratory exercise-based program, as showed in Fig. 1, included three parts: (i) warming-up; (ii) general exercises targetting specific breath patterns[20] (45 min); and (iii) relaxation exercises. Balls, sticks and hoops were used to facilitate exercise performance.

Patients were evaluated at entry (baseline) and after 4 weeks (post-treatment). Both evaluations included assessment of pain, dyspnea, number of tender points and self-administered questionnaires. Pain and dyspnea were assessed by the visual analogue scale (VAS, 0–10 cm scale, with 0 = 'no pain' or 'no dyspnea' and 10 = 'insupportable pain or dyspnea')[23,24] and the tender points according to the ACR (1990) criteria.[22] The following questionnaires were applied. (i) Fibromyalgia Impact Questionnaire (FIQ), a specific instrument

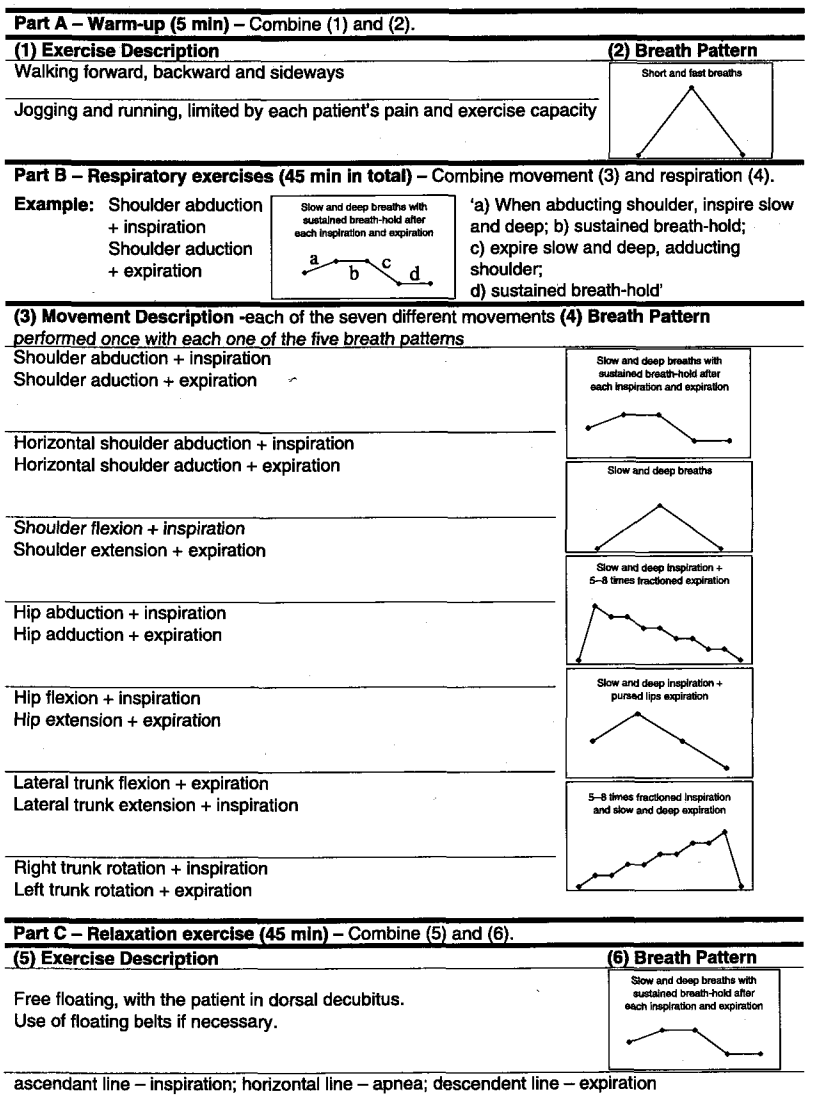

Figure 1 Description of the aquatic respiratory exercise-based program.

measuring functional disability and health status, consisting of 10 domains: physical impairment, days feeling good, work missed, job ability, pain, fatigue, rested (sleep), stiffness, anxiety and depression (Marques *et al.*[25] validated Portuguese version). Scores vary from 0 to 100 (100 indicates worst functional capacity). (ii) Medical Outcome Study 36 – Item Short Form (SF-36), a generic quality of life assessment questionnaire, with the eight domains: physical aspect, functional capacity, bodily pain, general health status, vitality, social aspect, emotional aspect and mental health (Ciconelli *et al.*[26] validated Portuguese version). Scores vary from 0 to 100 (100 indicates the best quality of life). (iii) Hamilton Anxiety Scale (HAS)[27] with scores ranging from 0 to 56 (values < 17 indicate mild symptoms, 18–24 mild to moderate and 25–30 moderate to severe anxiety). (iv) Pittsburgh Sleep Quality Index (PSQI) (Almondes and Araújo[28] validated Portuguese version) with scores varying from 0 to 21 (21 indicates the worst quality of sleep) and scores > 5 are considered indicative of bad quality of sleep.[29]

This study was reviewed and approved by the local institutional ethical committee.

Statistical analysis

Data were analysed using Stata, version 8.0 (StataCorp, College Station, TX, US). Demographic and baseline clinical characteristics were described using mean and

standard deviation (SD) for continuous measures (e.g. age, scale scores), and frequency and percentage for categorical variables. Baseline and post-treatment scores in the groups (within-patient effects) were analysed through paired *t*-test and comparison between groups by Student's *t*-test. Statistical significance was set at the 0.05 level.

RESULTS

Clinical and demographic characteristics at baseline

No significant difference was observed between the two groups at baseline (Table 1). The majority of women participating in the study were married (ARG = 15, CTL = 11) and White (19 in both groups). There was no difference in age (ARG = 46.61 ± 9.80 and CTL = 45.47 ± 8.65), weight (ARG = 65.22 ± 9.28, CTL = 63.94 ± 11.76) or height (ARG = 1.61 ± 0.09, CTL = 1.60 ± 0.08). Anti-inflammatory (ARG = 7, CTL = 6), antidepressive (ARG = CTL = 5) and analgesic medications (ARG = 8, CTL = 6), were used in both groups as prescribed before enrolment in the study and kept stable. Shortness of breath was reported by 72.22% of the patients in the ARG and by 70.59% in the CTL group and dyspnea, evaluated by VAS scale (0–10 cm), was also similar in both groups, 4.28 ± 3.12 and 3.65 ± 3.08, respectively.

The population studied consisted of severe affected patients presenting mean pain values > 7 on the 10-cm VAS (ARG = 7.50 ± 2.09; CTL = 8.47 ± 1.59) and FIQ pain-scale (ARG = 7.39 ± 1.93; CTL = 7.76 ± 2.05). Overall, all domains of FIQ scale score were similar in the two groups and > 5, physical function excepted (ARG = 4.79 ± 1.80; CTL = 4.17 ± 2.04). The FIQ total score was 6.64 ± 1.51 in the ARG group *vs* 6.22 ± 1.71 in the CTL group; feeling bad 6.83 ± 2.62 *vs* 6.39 ± 2.82; work missed 7.86 ± 2.73 *vs* 1.67 ± 2.31, p = 0.054); job ability 6.84 ± 1.87 *vs* 6.28 ± 2.31, respectively, in the ARG *vs* the CTL group. Regarding fatigue, morning tiredness, and stiffness in the ARG and in the CTL group the scores were also > 5: 7.21 ± 1.91 *vs* 6.64 ± 2.79, 7.60 ± 1.95 *vs* 6.35 ± 2.79 and 6.14 ± 2.30 *vs* 5.623.05, respectively. Similar values were observed for anxiety and depression

Table 1 Pain, anxiety, dyspnea, quality of sleep, functional capacity and quality of life of patients in the groups ARG (aquatic respiratory exercise-based program) and CTL (control) at baseline. Values expressed as mean (standard deviation)

Variable		ARG (n = 20)	CTL (n = 20)	P-value
Pain VAS (0–10)		7.50 (2.09)	8.47 (1.59)	0.133
Tender points (0–18)		16.33 (2.50)	16.59 (2.18)	0.750
Dyspnea VAS (0–10)		4.28 (3.12)	3.65 (3.08)	0.552
Anxiety HAS (0–56)		28.83 (10.15)	27.12 (10.37)	0.624
Quality of sleep PSQI (0–21)		13.17 (4.00)	11.82 (5.05)	0.388
SF-36 (0–100)	Physical functioning	40.28 (19.74)	44.12 (24.38)	0.611
	Role physical	11.11 (19.59)	27.94 (9.31)	0.109
	Bodily pain	21.22 (13.66)	29.00 (19.05)	0.173
	General health	50.94 (21.18)	45.94 (19.90)	0.477
	Vitality	32.50 (21.23)	40.15 (26.85)	0.355
	Social functioning	43.75 (26.86)	51.54 (29.57)	0.420
	Role emotional	14.82 (26.13)	25.10 (37.58)	0.352
	Mental health	41.11 (22.03)	39.12 (25.89)	0.807
FIQ 0–10	Total score	6.64 (1.51)	6.22 (1.71)	0.444
	Physical function	4.79 (1.80)	4.17 (2.04)	0.413
	Feel bad	6.83 (2.62)	6.39 (2.82)	0.636
	Work missed	7.86 (2.73)	1.67 (2.35)	0.054
	Job ability	6.84 (1.87)	6.28 (2.31)	0.433
	Pain	7.39 (1.93)	7.76 (2.05)	0.585
	Fatigue	7.21 (1.91)	6.64 (2.79)	0.483
	Morning tiredness	7.60 (1.95)	6.35 (2.69)	0.124
	Stiffness	6.14 (2.30)	5.62 (3.05)	0.571
	Anxiety	6.92 (2.21)	6.40 (3.19)	0.575
	Depression	6.12 (2.92)	6.35 (2.80)	0.818

VAS – Visual Analogue Scale; HAS – Hamilton Anxiety Scale; PSQI–Pittsburgh Sleep Quality Index; SF – 36–Short Form 36-Item Health Survey; FIQ – Fibromyalgia Impact Questionnaire; Except for SF-36, higher the scores, worst is the parameter.

in the two groups, respectively, 6.92 ± 2.21 (ARG) vs. 6.40 ± 3.19 (CTL), and 6.12 ± 2.92 (ARG) vs. 6.35 ± 2.80 (CTL).

Concerning the number of tender points, similar high numbers were obtained in both groups, 16.33 ± 2.5 in the ARG *vs* 15.59 ± 2.18 in the CTL group for a maximum value of 18.

The quality of sleep was severely impaired (PSQI > 5) in both groups (13.17 ± 4.00 in the ARG *vs* 11.82 ± 5.05 in the CTL group) and moderate to severe levels of anxiety were registered (HAS > 25), respectively, 28.83 ± 10.15 *vs* 27.12 ± 10.37, in the ARG *vs* CTL patients.

Baseline health-related quality of life was also greatly impaired in this sample of patients with fibromyalgia. It is worthwhile specifically noting the low scores in the physical, bodily pain and emotional component summary of the SF-36: 11.11 ± 19.59 (ARG) *vs* 27.94 ± 9.31 (CTL); 21.22 ± 13.66 (ARG) *vs* 29.00 ± 19.05 (CTL); and 14.82 ± 26.13 (ARG) *vs* 25.10 ± 37.58 (CTL), respectively. The scores of the remaining five domains were all below or around 50: physical functioning 40.28 ± 19.74 (ARG) *vs* 44.12 ± 24.38 (CTL); general health 50.94 ± 21.18 (ARG) *vs* 45.94 ± 19.90 (CTL); vitality 32.50 ± 21.23 (ARG) *vs* 40.15 ± 26.85 (CTL); social functioning 43.75 ± 26.86 (ARG) *vs* 51.54 ± 29.57 (CTL); and mental health 41.11 ± 22.03 (ARG) *vs* 39.12 ± 25.89 (CTL).

The five patients that did not complete the study (2 from the ARG group and 3 from the CTL) were not different from the remaining subjects (data not shown).

Efficacy

After completion of the exercise program, as demonstrated in Table 2, ARG patients showed a significant loss of weight and improvement (> 25%) statistically significant in VAS-pain and VAS-dyspnea, as well as in HAS-anxiety (progressing from moderate to severe levels to mild to moderate anxiety symptoms). Regarding PSQI-quality of sleep, patients in the ARG group reached scores inferior to the median PSQI scores reported for patients with fibromyalgia (median [IC 25–75%] $12.0^{[10-16]}$)[29] (Table 2). CTL patients showed only a 10% decrease in the VAS-pain scale and no improvement in VAS-dyspnea, HAS-anxiety and PSQI scores.

The ARG program was associated with significant improvement in 7/10 domains and in the total score of FIQ (Table 3), comparing baseline and post-treatment assessments. A 20% reduction ($P < 0.001$) was observed in the mean FIQ total score while no alteration in the total or in any domain of the specific FIQ instrument was verified in the CTL group. 'Work missed', 'fatigue' and 'morning tiredness' were the FIQ items that retained a significant reduction when the two groups were compared.

Table 4 shows the SF-36 scores, demonstrating significant improvement (≥ 20%) in the ARG group in 5/8 domains (physical functioning, bodily pain, vitality and social functioning and emotional role) compared with the CTL group. When the differences before and after intervention in the ARG group were considered,

Table 2 Comparison between baseline and post-treatment evaluations in ARG (aquatic respiratory exercise-based program) and CTL (control) groups regarding weight, pain, tender points, dyspnea, anxiety and quality of sleep

		Baseline and post-treatment mean difference (SD)	95% CI	*P*-value, baseline *vs* post-treatment	*P*-value, ARG ($n = 18$) *vs* CTL ($n = 17$)
Weight, kg	ARG	1.40 (0.38)	0.59–2.21	0.002*	0.001*
	CTL	−0.12 (0.17)	−0.48–0.24	0.496	
Pain, VAS (0–0)	ARG	2.83 (0.65)	1.47–4.20	0.001*	0.029*
	CTL	1.00 (0.46)	0.02–1.98	0.046*	
Tender points 0–18	ARG	0.89 (0.82)	−0.83–2.61	0.291	0.110
	CTL	−0.59 (0.33)	−1.29–0.12	0.096	
Dyspnea VAS, 0–10	ARG	2.56 (0.71)	1.06–4.05	0.002*	0.040*
	CTL	0.29 (0.79)	−1.38–1.97	0.714	
Anxiety HAS, 0–56	ARG	8.00 (2.01)	3.76–12.24	0.001*	0.005*
	CTL	−1.00 (1.21)	−5.68–3.68	0.657	
Quality of sleep PSQI, 0–21	ARG	3.22 (1.15)	0.81–5.64	0.012*	0.004*
	CTL	−2.06 (1.28)	−4.77–0.65	0.127	

VAS – Visual Analogue Scale; HAS – Hamilton Anxiety Scale; PSQI – Pittsburgh Sleep Quality Index positive values indicated improvement in the parameters; *significance level $P < 0.05$.

Table 3 Comparison between baseline and post-treatment evaluations in the ARG (aquatic respiratory exercise-based program and CTL (control) groups regarding functional capacity assessed by the Fibromyalgia Impact Questionnaire (FIQ)

FIQ		Baseline and post-treatment mean difference (SD)	95% CI	*P*-value, baseline *vs* post-treatment	*P*-value, ARG (n = 18) *vs* CTL (n = 17)
Total score	ARG	2.08 (0.46)	1.10–3.06	0.001*	0.050*
	CTL	0.03 (0.58)	−0.66–0.72	0.933	
Physical function	ARG	0.27 (0.50)	−0.78–1.33	0.592	0.697
	CTL	−0.53 (0.40)	−1.38–0.32	0.205	
Feel bad	ARG	2.70 (0.67)	1.28–4.12	0.001*	0.139
	CTL	0.25 (1.07)	−2.01–2.51	0.816	
Work missed	ARG	1.35 (0.69)	−0.10–2.80	0.066	0.036*
	CTL	−0.22 (0.19)	−0.17–0.62	0.249	
Job ability	ARG	1.76 (0.60)	0.47–3.03	0.001*	0.185
	CTL	−0.06 (0.72)	−1.58–1.46	0.936	
Pain	ARG	2.28 (0.68)	0.86–3.71	0.004*	0.079
	CTL	0.26 (0.44)	−0.68–1.20	0.568	
Fatigue	ARG	2.77 (0.75)	1.19–4.35	0.002*	0.013*
	CTL	−0.26 (0.35)	−1.01–0.48	0.463	
Morning tiredness	ARG	3.08 (0.71)	1.58–4.57	0.001*	0.007*
	CTL	−0.41 (0.52)	−1.51–0.70	0.448	
Stiffness	ARG	1.31 (0.71)	−0.20–2.82	0.084	0.476
	CTL	0.21 (0.64)	−1.14–1.57	0.745	
Anxiety	ARG	1.71 (0.53)	0.59–2.83	0.005*	0.052
	CTL	−0.79 (0.72)	−2.32–0.74	0.288	
Depression	ARG	2.11 (0.86)	0.29–3.92	0.026*	0.159
	CTL	0.08 (0.36)	−0.68–0.85	0.8225	

FIQ – Fibromyalgia Impact Questionnaire (0–10), positive values indicated improvement in the FIQ parameters; *significance level $P < 0.05$.

Table 4 Comparison between baseline and post-treatment evaluations in the ARG (aquatic respiratory exercise-based program) and CTL (control) groups regarding quality of life – SF-36

		Baseline and post treatment mean difference (SD)	95% CI	*P*-value, baseline *vs* post-treatment	*P*-value, ARG (n = 18) CTL (n = 17)
Physical functioning	ARG	−12.22 (5.16)	−23.12–−1.33	0.030*	0.208
	CTL	−2.94 (5.04)	−13.62–7.74	0.568	
Role physical	ARG	−29.17 (9.95)	−50.16–−8.17	0.009*	0.001*
	CTL	20.59 (7.80)	4.06–37.12	0.018*	
Bodily pain	ARG	−23.11 (4.47)	−32.54–−13.68	0.001*	0.001*
	CTL	2.00 (3.23)	−4.84–8.84	0.544	
General health	ARG	−4.33 (5.18)	−15.27–6.61	0.415	0.761
	CTL	−6.53 (4.90)	−16.91–3.85	0.201	
Vitality	ARG	−20.00 (5.73)	−32.09–−7.91	0.003*	0.001*
	CTL	2.50 (5.62)	−9.42–14.42	0.662	
Social functioning	ARG	−21.53 (7.62)	−37.60–5.46	0.012*	0.009*
	CTL	11.84 (5.30)	0.60–23.08	0.040*	
Role emotional	ARG	−29.63 (8.89)	−48.39–−10.87	0.004*	0.001*
	CTL	17.26 (7.77)	0.78–33.73	0.041*	
Mental health	ARG	−18.44 (5.57)	−30.21–−6.68	0.004*	0.190
	CTL	−8.18 (5.24)	−19.28–2.92	0.138	

SF-36 – Short Form 36-Item Health Survey (0–100, negative values indicated improvement in the quality of life domains; *significance level $P < 0.05$.

improvement was detected in another two domains: functional capacity and mental health. Regarding the CTL group, significant worsening was observed in the physical, social and emotional domains.

DISCUSSION

Our results showed improvement in pain, dyspnea, anxiety, quality of sleep, functional capacity and quality of life (in the physical, social and emotional as well as vitality and pain domains) in the treated subjects. So far, to our knowledge, this is the first time that an aquatic respiratory exercise-based program has been employed in the treatment of fibromyalgia patients.

Nonpharmacologic interventions in FM have been reported focusing on stretching and aerobic exercises[10,30] physical therapy, acupuncture, massage or cognitive behavioural therapies[1] applied as isolated methods or in combination with other techniques. This study proposes an aquatic respiratory exercise-based program founded on the therapeutic principles of warm water[16,17] associated with the well-being and relaxation induced by respiratory exercises.[21,31,32] The exercises or movements performed as part of this program are designed as auxiliary elements to reach the proper respiratory patterns.

The thermal beneficial effects of water are supported by the results of six controlled studies that assessed the effects of the isolated immersion in hot water in patients with fibromyalgia.[17,33–37] Controlled temperature may produce a sedative effect both as a result of causing peripheral vasodilatation and of activating the asympathetic system which increases accumulation of acetylcholine in the central nervous system[38] while aquatic exercises or movements carry on the advantages of the biophysical properties of immersion as buoyancy, hydrostatic pressure gradient and water viscosity.[39] Most of the respiratory techniques used in this research are based on a Yoga breathing technique ('pranayama'), where the efforts are concentrated on using the abdominal and diaphragm muscles to reach maximum inspiratory pulmonary capacity, and to later exhale in a controlled and supported way.[40] Studies have demonstrated the positive effects of such respiratory exercise in subjects with lung cancer[41] asthma[42] and after stem cell transplantation.[21]

This unique program proposed for the treatment of FMS was controlled, supervised and individualized according to the rhythm of each patient, and also showed acceptable compliance and clearly demonstrated beneficial effects. Despite the difficulties of this kind of open study, a control group, submitted only to social and recreational activities, was established. In this pilot study our major concern was to exclude the effects of socialization and of sharing experiences that inevitably occur between patients with similar complains of pain and daily life difficulties submitted to any type of group intervention.

Additionally, the effect of the proposed treatment was evaluated not only by VAS-pain and number of tender points but also by four different translated questionnaires, cross-culturally adapted and validated[25–28] and applied in FMS treatment protocols.[1] Therefore, this study evaluated more than specific aspects of the disease (FIQ – Fibromyalgia Impact Questionnaire) and general quality of life (SF-36), by including appraisal of some communally associated symptoms, namely quality of sleep (Pittsburgh Sleep Quality Index – PSQI), anxiety (Hamilton Anxiety Scale – HAS) and dyspnea (VAS scale) symptoms.

The observed improvement in pain deserves further discussion. Patients in the ARG group presented a significant reduction in perceived pain, when assessed by the VAS scale and by the bodily pain domain of SF-36 as well as by the specific FIQ score. However, there was no decrease in the number of tender points. Counting tender points is a method of assessment that only allows dichotomic alternatives. Therefore, if the patient has a specific point that hurts 'very much' and after intervention hurts 'a little', the test result will be the same and no changes in the number of tender points will be detectable. A recent paper[43] has already pointed out the utility of the number of tender points as a diagnostic tool and not as an outcome measure, emphasizing its dichotomic though quantitative nature. Therefore, our findings, in accordance with some published population studies[44–46] also cast doubt on the utility of tender points as a valid measure for treatment response in patients with fibromyalgia. It is interesting to note that the CTL group showed a modest reduction in VAS-pain (10%) but not in the more specific pain-related domains of SF-36 and FIQ questionnaires.

Regarding dyspnea, this symptom has a complex physiopathology and could be related to anxiety or depression. It is rarely reported in association with fibromyalgia. However, dyspnea was reported in 52% of 200 Brazilian patients with fibromyalgia[47] and in our study 25 of the 35 subjects (71.43%) related some degree of dyspnea at the baseline evaluation. After treatment, the intensity of this symptom improved only in the ARG group, as anticipated, with the breathing technique applied.

A marked improvement in anxiety was observed in the ARG group when a specific instrument (HAS,

$P = 0.005$) was applied and a strong tendency to improvement was verified when assessed by FIQ ($P = 0.052$). This was expected as this protocol adds the possible benefits of warm water[48] and relaxation exercises,[21,42] both non-pharmacological interventions already described with beneficial effects on anxiety symptoms.

Sleep disturbance is a key component of the fibromyalgia syndrome observed in the majority of patients. Many of the daytime symptoms in these patients such as morning aching, fatigue and stiffness may be related to these sleep disturbances. Thus the improvement observed in the quality of sleep of the patients in the ARG group potentially has practical consequences in their daily activities and can be at least in part attributed to the respiratory exercises. Khalsa[49] verified the effects of Yoga (emphasizing meditation and respiratory exercises) in the quality of sleep of healthy subjects. In this study improvement in several parameters of sleep, such as efficiency and total time of sleep, was observed. This is an important advantage of this protocol, using respiratory exercises in this relaxing way. Additionally, in favour of this combined technique protocol is the observation that improvement in the quality of sleep was not detected in the three studies that analyzed this parameter[12–14] using only aquatic exercises.

When analyzing the improvement in the functional capacity (assessed through FIQ scores), our study showed a positive practical result. The reduction in the loss of work found in our research is remarkable ($P = 0.036$), diverging from the results of all the studies that analyzed water therapies in patients with fibromyalgia. The importance of a better quality of sleep in the observed improvement in worked missed, fatigue and morning stiffness cannot be ignored. It is also worthwhile noting the wide range of improvement observed in 5/8 domains of the SF-36 scores (physical aspect, pain, vitality, social aspect and emotional aspect). If we consider the results before and after treatment in the ARG group, no difference was observed only in the general health domain, unlike any other interventions.

This aquatic respiratory exercise-based program was applied only for 4 weeks and demonstrated a wide spectrum of beneficial effects. Similarly studies involving only water immersion, unlike exercise programs, are mostly of short duration ranging from a maximum of 3 weeks to 10 days. Of the eight water immersion studies analyzed[17,33–37,50,51] four showed improvement in FIQ total score, two improved the quality of sleep, two the fatigue, two the anxiety and five the depression scores. Neumann *et al.*[36] also found improvement in 5 domains of the SF-36: physical aspect, social aspect, pain, mental health and vitality after a 10-day balneotherapy. Of course, others factors like socialization or environmental changes could be implied in these positive responses. In our study the effects of relaxation induced by the Yoga breathing technique ('pranayama') cannot be neglected. This technique is recommended for treating depression[52–54] and stress.[52,55,56] It also improves physical and mental health[55,56] enthusiasm and alertness[56] and attention.[53] The 'pranayama' also involves physiological effects, such as reducing rest heart rate,[55] respiratory frequency,[19] consumption of oxygen,[57] and number and intensity of palpitations in subjects with benign arrhythmias.[58] Most of the respiratory techniques used in this research are based on the principles of Yoga, as types 1, 2 and 6 (Fig. 1) and it is probable that part of the results observed in this research is due to the respiratory technique performed.

We cannot exclude the possibility that the interaction between the therapists and the patients during the treatment period might have influenced some of the outcomes, as well as the limitations of a sedentary control group. We have considered the placebo effect of physical activity *vs* no activity at all, but the wide range and degree of positive results, particularly observed with the more specific instruments, like FIQ, support the value of this program and the necessity of further studies with more straightforward control groups. Due to the frequency of the exercise program and allocated swimmingpool time it was not possible to simultaneously conduct an aquatic recreational program in the control group, but certainly this will be addressed in future protocols.

The absence of further evaluations is a major shortcoming of this study. It would allow the assessment of the duration of the observed positive results. On the other hand, this is the first study with this technique, emphasizing respiratory patterns and breathing awareness. Once its short-term effectiveness is established, further studies can be developed in order to define the best program duration and frequency, persistence of effects as well as its utility as a first step or concomitant program, preparing patients for more strenuous stretching or aerobic exercises, and consequently improving adherence and leading to better and more persistent results.

In summary, these results show the benefits of short-term aquatic respiratory exercises, emphasizing the importance of breathing, of respiratory awareness during exercises, improved pain, dyspnea, anxiety and quality of sleep in women with fibromyalgia. Furthermore, functional capacity enhancement, reduction in fatigue and missed

working days were also observed. This exercise program improved the quality of life, in its physical, social and emotional aspects, as well as the vitality of women with fibromyalgia. Although further studies are needed, our results suggest that an aquatic respiratory exercise-based program could become a useful tool in the management of this disease.

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