ORIGINAL ARTICLE

Pilates training improves pain and quality of life of women with fibromyalgia syndrome

A prática de Pilates melhora a dor e a qualidade de vida em mulheres com síndrome fibromiálgica

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ABSTRACT

BACKGROUND AND OBJECTIVES: There is still lack of evidence that supports Pilates training in women with fibromyalgia syndrome. Hence, the aim of the present study was to assess the effects of Pilates on pain, quality of life, depression and anxiety in women with fibromyalgia syndrome.

METHODS: Twenty female volunteers diagnosed with fibromyalgia took part on this study. Thirteen women were assigned for the treatment group and seven, for the control group. All 20 patients were evaluated before and immediately after 8 weeks. Along with the anamnesis, volunteers were assessed for the 18 tender points described by the American College of Rheumatology, for number of painful regions, pain intensity with the visual analogue scale, quality of life with the Fibromyalgia Impact Questionnaire, for depression with the Beck Depression Inventory and for anxiety with the Beck Anxiety Inventory. The treated group underwent a 1-hour Pilates session twice a week for 8 weeks. The control group remained with prior treatment interventions and therapies unchanged.

RESULTS: Statistically significant improvement was observed in pain intensity and number of painful regions ($p<0.05$) in the treated group, whereas no statistical differences were found in other variables ($p>0.05$) or for the control group ($p>0.05$). Strong correlations were found mostly between number of active tender points and Fibromyalgia Impact Questionnaire ($r>0.8$, $p<0.05$).

CONCLUSION: The results support Pilates as a safe physical therapy resource in improving pain for fibromyalgia patients.

Keywords: Pain, Fibromyalgia, Pilates, Quality of life, Rehabilitation.

RESUMO

JUSTIFICATIVA E OBJETIVOS: Ainda faltam evidências que apoiem o treino de Pilates em mulheres com fibromialgia. O objetivo deste estudo foi avaliar os efeitos do Pilates na dor, qualidade de vida, depressão e ansiedade em mulheres com fibromialgia.

MÉTODOS: Vinte mulheres com diagnóstico de fibromialgia foram voluntárias do estudo. Treze foram aleatoriamente alocadas para o grupo tratamento e sete para o grupo controle. Todas as 20 pacientes foram avaliadas antes e imediatamente após o tratamento de 8 semanas. Junto com a anamnese, avaliaram-se os 18 *tender points* descritos pelo *American College of Rheumatology* para classificação da fibromialgia. Além disso, avaliou-se o número de regiões dolorosas, a intensidade da dor com a escala analógica visual, a qualidade de vida pelo Questionário de Impacto da Fibromialgia, a depressão pelo Inventário de Depressão de Beck e a ansiedade pelo Inventário de Ansiedade de Beck. O grupo tratamento realizou sessões de 1h de Pilates duas vezes por semana por 8 semanas. O grupo controle continuou com seus tratamentos anteriores ao estudo sem modificações.

RESULTADOS: Melhora estatisticamente significativa foi observada na intensidade da dor e no número de regiões dolorosas ($p<0,05$) no grupo tratado, ao passo que não há diferenças estatísticas para outras variáveis ($p>0,05$) ou para o grupo controle ($p>0,05$). Foram encontradas fortes correlações principalmente entre o número de *tender points* ativos e o Questionário de Impacto da Fibromialgia ($r>0,8$, $p<0,05$).

CONCLUSÃO: Os resultados obtidos apoiam o Pilates como um recurso fisioterapêutico seguro para melhorar a dor em pacientes com fibromialgia.

Descritores: Dor, Fibromialgia, Pilates, Qualidade de vida, Reabilitação.

INTRODUCTION

Fibromyalgia (FM) is a poorly understood non-inflammatory chronic pain condition in which patients experience pain in the four quadrants of their body[1]. Besides pain, patients suffer from sleep disturbances, fatigue, and mood disorders[2,3]. Despite of its unknown etiopathogenesis[4-6], peripheral, spinal and supraspinal changes have been implied in its pathogenesis[6]. Other FM characteristics include allodynia[7-9], hyperalgesia[7-9], lower pain threshold[7,8], and specific points sensitive to palpation, denominated tender points[4,6,7,10]. Some symptoms are associated to this syndrome, such as morning stiffness[1,3], chronic cephalalgia[4,11], migraine[4,10], functional gastrointestinal disorders[1,7], anxiety and depression[1,5,9].

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The overall prevalence of fibromyalgia varies between 0.4 and 9.4 % in the literature[12]. The economic burden of this disease is very high. Health-related costs are estimated as more than €10,000 per year per patient in France and more than $11,000 per patient per year in te US population[13,14]. In Brazil, prevalence of FM was estimated in about 2.5%; in females, this prevalence increases up to 3.9%[15]. Santos et al.[16] evaluated the prevalence of FM in an elderly population, and they found it slightly higher than other studies, about 5.5%. In a low socioeconomic status population, the prevalence of FM is similar to a more diverse socioeconomic population[17].

Randomized controlled trials and systematic reviews have consistently supported physical activity as a beneficial modality for chronic pain, physical function, sleep, cognitive function, and overall health and disease risk modification[18]. In a very recent study, the only "strong-for" therapy-based recommendation was exercise[19]. Among different exercise modalities, researches show good results especially with aerobic exercises, which have been shown to improve physical capacity of patients with FM along with symptoms and physical function[20,21]. However, other exercise modalities might be used, and one of them is Pilates.

The Pilates exercises aim at improving general flexibility and health focusing on the "powerhouse" formed by the core muscles (diaphragm, transversus abdominus, multifidus, and the pelvic floor muscles). It also enhances posture and breath coordination combined with other movements[22]. Pilates practice may be an option of physical activity on fibromyalgia treatment as literature points out some advantages of the method: fitness[23], functional ability[22], flexibility[22,23] and dynamic balance improvement[24], besides minimizing unnecessary muscle recruitment, which may cause fatigue, instability and recovery impairments[22]. Given those conditions, another advantage would be better adhesion to the treatment[8]. Thus, the aim of this study was to verify the effects of Pilates practice on pain and quality of life of women with fibromyalgia. Our hypothesis is that Pilates practice improves pain symptoms in that population.

METHODS

After disclosure through radio stations and the Health Teaching Unit of Federal University of São Carlos (SP, Brazil), thirty-seven FM patients showed interest in participating in this longitudinal prospective randomized controlled trial.

Benefits and potential adverse effects were well explained to each volunteer prior to the signature of the consent term, and were thoroughly described in it.

Sample size was determined using ENE 3.0 software (GlaxoSmithKline, Madrid, Spain), and was based on a significance level of .05 and a power of 0.80 to detect a difference of 15% in the Fibromyalgia Impact Questionnaire (FIQ) score, as according to Bennet et al.[25], a 14% change in FIQ total score is considered clinically relevant. Based on these criteria, seven participants were required in each group. Inclusion criteria were having medical fibromyalgia diagnosis, classified according to the 1990 *American College of Rheumatology* (ACR) diagnosis criteria[26], being of female gender, and aged over 18 years. Exclusion criteria were having cognitive deficits which would prevent patients of understanding the study, uncontrolled or unmonitored chronic illnesses and drug and/or alcohol abuse. The ACR fibromyalgia classification of 1990 was used, although there are new criteria of 2010; however, a recent study has demonstrated that there is good agreement between the 1990 and 2010 ACR criteria for FM diagnosis[27]. Volunteers who agreed to take part in the study were randomly assigned to Treatment Group (TG) or Control Group (CG), and received an opaque envelope with the assignment to one group. Main assessor (MAA) was blind to patients' allocation.

All volunteers underwent two similar evaluations, one before treatment and one in the week following the end of 8 weeks of treatment. All evaluations were conducted at the Laboratory for Assessment and Intervention on Women's Health, Federal University of São Carlos. Besides the interview and tender points counting, women were assessed for number of painful body regions, greatest level of pain with the visual analogue scale (VAS), impact of fibromyalgia with FIQ, validated for Brazilian population[28], depression with the Beck Depression Inventory (BDI)[29] and anxiety with the Beck Anxiety Inventory (BAI)[30,31]. A clinically relevant change in VAS score was considered of about 15-20%[32]; for the FIQ score, this change was of 14%[25].

The proposed treatment consisted of two 1-hour weekly sessions of Pilates, during eight weeks. The protocol was applied by the same physical therapist (MK), who received 10 hours of specific training for this protocol by an experienced Pilates instructor and physical therapist (MMC). The protocol consisted of mat Pilates exercises for trunk, upper and lower limbs. During all sessions, patients were constantly oriented to maintain the correct pelvis and shoulder positioning, and the core contraction, associating the respiratory pattern according to each proposed exercise, following the methods principles.

Patients in the treated group (TG) were divided in 4 groups with up to 5 patients each and those groups were treated on the same day. Treatment progressed by increasing the number of repetitions for each exercise, following each patient's own limitations. Patients were informed that the number of repetitions of each exercise might not be the same for all participants, and were oriented to perform the exercises at submaximal intensity (subjectively controlled by each patient, and by MK through observation of fatigue, pain or weariness signs). By the end of treatment, patients received guidelines on the treatment protocol exercises, in case they were interested in continuing treatment at home.

Control group (CG) patients did not receive any interventions during the 8 weeks of the TG treatment, besides those they were already receiving. After the last evaluation, CG patients were offered to be referred to other physical therapy services.

Statistical analysis

Comparisons were performed before and after treatment period for the variables of painful regions, VAS, number of active tender points, FIQ, BAI and BDI scores.

Shapiro Wilk's W and Levene's tests showed normal distribution and homogeneity of data. Hence, a paired Student t test was

used to verify the differences intra-groups. Correlations were performed with Pearson Correlation Coefficient. A strong correlation was considered if r>0.75, moderate if 0.75<r<0.5 and mild if r<0.5. For all variables, a significance level of 5% was adopted. STATISTICA software (v. 7.0, StatSoft Inc., Tulsa, OK, USA) was used to carry out the analysis. Effect sizes for all quantitative variables were measured with Cohen d coefficient. An effect size greater than 0.8 was considered large, around 0.5 moderate, and less than 0.2 small[33].

The local ethics committee approved the study (report number 404/2009), which is in compliance with the Declaration of Helsinki, and participants have signed an informed consent, according to Resolution 196/96 of the National Health Council (Health State Department, Brazil).

RESULTS

Figure 1 shows the flowchart of the study. The dropout rate for the control group was 53%. The main reason for dropping out was symptoms aggravation reported by CG patients. Hence, the whole analysis was carried out taking into account only the individuals who finished the whole study. For those people, clinical and demographical characteristics are described in tables 1 and 2, respectively. In the beginning of treatment, patients were asked to inform about any changes in their medication or other treatments received, which did not occur during the study duration.

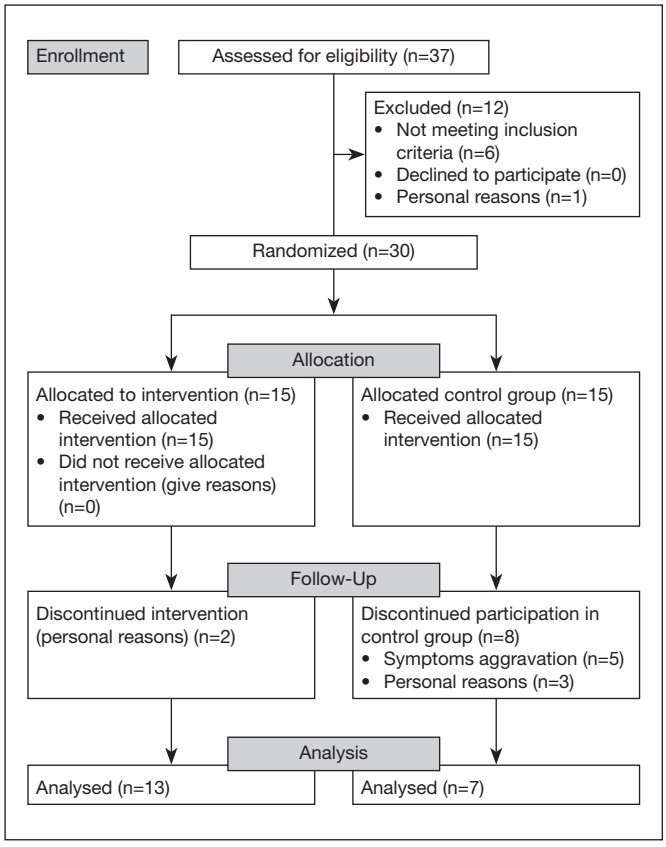

Figure 1. Flowchart of the study

Table 1. Sample clinical characteristics

Variables	Control group (CG) (n=7)	Treated group (TG) (n=13)	P value*
Age (years)	53.29±12.27	47.85±9.82	0.293
Weight (kg)	69.86±15.14	74 ±13.72	0.542
Height (m)	1.62±0.04	1.65±0.07	0.438
BMI (kg/m^2)	26.33±4.86	27.33±5.11	0.676
Sessions	-	9.38±4.07	-

BMI = body mass index; * p<0.05.

Table 2. Sample demographic characteristics

Variables	Control group (CG) (n=7)	Treated group (TG) (n=13)	Total
Marital Status			
With marital status	4	7	11
Without marital status	3	6	9
Education			
Elementary school	2	1	3
Secondary school	1	1	2
Incomplete high school	0	1	1
High school	1	4	5
Incomplete college	1	1	2
College	1	5	6
Master's degree	1	0	1
Physical activity			
Yes	2	6	8
No	5	7	12
Psychological attendance			
Yes	0	1	1
No	7	12	19

Table 3 presents results of analyzed variables. CG did not show significant differences between the first and the last evaluation for any variable. TG showed significant improvement in the number of pain regions and pain intensity after treatment. Differences between TG and CG before and after treatment were not significant. Effect sizes were considered large for both number of pain regions and pain for the TG.

Strong positive correlation was found between number of tender points and FIQ score for CG (r=0.8164, p<0.05). For TG, strong positive correlations were found between BAI and BDI scores (r=0.8509, p<0.05) and number of tender points and FIQ score (r=0.8575, p<0.05) before treatment. After treatment, strong positive correlations were found again between BAI and BDI scores (r=0.8669, p<0.05), number of tender points and FIQ score (r=0.7514, p<0.05) and BAI and FIQ scores (r=0.8837, p<0.05). A moderate positive correlation was found between number of tender points and BAI score (r=0.6991, p<0.05).

Considering all patients from both groups (CG and TG), moderate correlations were found between BAI and BDI scores (r=0.7268, p<0.05) and between number of tender points and FIQ score (r=0.6458, p<0.05) before treatment. After treatment

Table 3. Results of pain regions, visual analogue scale, tender points and questionnaires before and after treatment

Variables	Control group (n=7)				Treated group (n=13)			
	Before treatment	After treatment	P value	Cohen d (95%CI)	Before treatment	After treatment	P value	Cohen d (95%CI)
Pain regions	2.14±0.69	2.00±1.00	0.77	0.16 (-0.90 – 1.20)	2.69±0.48	1.85±1.14	0.02	0.96 (0.12 – 1.74)
VAS (pain)	6.86±2.12	6.71±3.09	0.92	0.06 (-1.00 – 1.10)	8.88±1.00	6.08±3.35	0.01	1.13 (0.27 – 1.92)
Tender points	11.00±3.92	8.29±4.79	0.27	0.62 (-0.49 – 1.64)	13±3.92	11.69±5.57	0.49	0.27 (-0.51 – 1.04)
FIQ	58.29±18.94	42.79±20.09	0.16	0.79 (-0.34 – 1.82)	68.85±22.11	54.96±29.66	0.19	0.53 (-0.27 – 1.30)
BAI	18.43±12.41	15.71±11.94	0.68	0.22 (-0.84 – 1.26)	20.92±14.70	17.15±12.67	0.49	0.27 (-0.51 – 1.04)
BDI	14.14±7.29	11.71 ± 5.71	0.50	0.37 (-0.71 – 1.40)	18±11.31	16.46±13.07	0.75	0.12 (-0.65 – 0.89)

CI = Confidence Interval; VAS= Visual Analogue Scale; FIQ = Fibromyalgia Impact Questionnaire; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory.

a strong positive correlation was found between BAI and FIQ scores (r=0.8170, p<0.05). Moderate positive correlations were found between BAI and BDI scores (r=0.7096, p<0.05), FIQ and BDI scores (r=0.6701, p<0.05), number of tender points and FIQ score (r=0.7296, p<0.05) and number of tender points and BAI score (r=0.6050, p<0.05) after treatment for all patients.

DISCUSSION

Our results showed that Pilates treatment has positive effects on pain intensity and painful regions of women with fibromyalgia. Favorable results in fibromyalgia treatment with Pilates were also found by Altan et al.[8]. There are some hypotheses that may explain the increase in pain threshold in active people when compared to sedentary. The most studied and accepted in humans is the induced analgesia by the release of opioids. If regularly practiced, an exercise of the same intensity and duration releases exponentially more endorphins[34].

The growth hormone (GH) also participates in pain modulation; its secretion directly depends on the load and frequency of exercises practice[34]. Studies with healthy subjects show that the lack of sleep reduces GH concentration and can cause pain similar to the diffuse pain experienced by fibromyalgia patients[10,34]. Improvement in sleep quality after exercise practice was not directly evaluated in this study, but might be one of the benefits of exercise practice in fibromyalgia. Since other variables related to the treatment of fibromyalgia, pharmacological and nonpharmacological, remained the same for each individual patient, significant positive differences observed in TG can be attributed to the treatment protocol.

Aerobic exercise does not need to be of high or submaximal intensity to have an effect on pain as it was believed[34]; in that sense, positive results observed in this study support the use of Pilates as a form of physical therapy treatment of fibromyalgia. Depression and anxiety associated with fibromyalgia showed no significant improvement both in CG and in TG. These data seem to point to the fact that the intensity of pain may not be directly linked to depression and anxiety, which was also presented by Buskila[10]. Pilates itself does not seem to influence these psychological aspects enough to be detected by the instruments we used, which may point to the need of associated psychotherapy for these patients.

The number of active tender points was assessed in this study. In spite of the improvement of pain intensity in these points, there was no significant difference between evaluations with regard to the number of active tender points. Martinez et al.[35] correlated the number of active tender points to pain intensity perception by VAS and fatigue, quality of life, depression and anxiety by the simplified Health Assessment Questionnaire and found a significant correlation among number of active tender points, pain intensity and impact on functional quality. Strong correlations were found mostly between number of active tender points and FIQ, before and after treatment for both groups. Quality of life may then be compromised by pain presented by FM patients. Tender points were characteristic of FM, and even though new FM diagnostic criteria have been developed, the 1990 ACR criteria may be used as well. New and old criteria should coexist as they enable a major understanding and ease the management of this prevalent disease[36], as they show good agreement[27,36].

Whereas treated group presented a greater pain level in the beginning, which levelled up with the control group at the end of the study, we consider our results as positive, given that an improvement of 14% in the FIQ score is considered clinically relevant[25]; treated group presented an improvement of 20% in the FIQ score after treatment, and 31.5% improvement in pain intensity measured by VAS, which can be considered clinically relevant[32].

Even though patients in the TG have higher education than those of the CG, no specific tests for cognitive deficits (such as the Mini-Mental State Examination) were performed, and it is not possible to stablish a direct relationship of school years and cognitive deficits in our population. Usually, FM patients present anxiety and also cognitive complaints, and they might be related[37].

The safety of Pilates treatment could be observed, as no side effects were reported by our patients after treatment sessions, which agrees with results of Altan et al.[8]. Some studies on the Pilates method, either as treatment or as adjuvant in promoting health of athletes and healthy individuals indicate that the benefits of Pilates depend on the regularity of their practice, and are observed only in the short term[8,38,39]. Pilates practitioners may experience adverse events, such as aggravation of their previous condition, injury or excessive muscle tension; more severe conditions are not common[40]. Reported ill-effects of Pilates exercise include single cases of diaphragmatic rupture[41] and dislodgement of a breast implant[42], but none of the cases happened in FM patients. The adverse effects of Pilates seem to be related

to poor client concentration and technique; inadequate training of instructors, inappropriate exercise prescription, rapid exercise progression, and excessive loads[40]. Nonetheless, patients in the present study did not report any adverse effects.

Even though not statistically significant, CG patients showed some improvement, which might be related to the Hawthorne effect, wich has been defined as 'an increase in worker productivity produced by the psychological stimulus of being singled out and made to feel important'[43]; probably, CG patients felt well by receiving and being taken care of, which could explain our results.

The main limitation of the study is the small sample size along with the high dropout rates presented by the CG. Given that the CG did not receive any kind of physical therapy treatment, it may have directly influenced the adherence to the study. Another point is that this lack of treatment may raise the question whether the proposed treatment differs from other conventional physical therapy modalities. Hence, further studies with larger sample sizes and different physical therapy modalities are required. Another suggestion could be the monitoring of long-term effects of Pilates treatment in people with fibromyalgia[44].

CONCLUSION

There was improvement in pain intensity, quality of life and the number of painful regions after treatment with the Pilates method. Thus, the results of this study support Pilates practice as a form of physical therapy for fibromyalgia.

REFERENCES

1. Clauw DJ. Fibromyalgia: a clinical review. JAMA. 2014;311(15):1547-55.
2. Wolfe F, Häuser W. Fibromyalgia diagnosis and diagnostic criteria. Ann Med. 2011;43(7):495-502.
3. Plazier M, Ost J, Stassijns G, De Ridder D, Vanneste S. Pain characteristics in fibromyalgia: understanding the multiple dimensions of pain. Clin Rheumatol. 2015;34(4):775-83.
4. Brill S, Ablin JN, Goor-Aryeh I, Hyat K, Slefer A, Buskila D, et al. Prevalence of fibromyalgia syndrome in patients referred to a tertiary pain clinic. J investig Med. 2012;60(4):685-8.
5. Chakrabarty S, Zoorob R. Fibromyalgia. Am Fam Physician. 2007;76(2):247-54.
6. Robinson ME, Craggs JG, Price DD, Perlstein WM, Staud R. Gray matter volumes of pain- related brain areas are decreased in fibromyalgia syndrome. J Pain. 2011;12(4):436-43.
7. Chong YY, Ng BY. Clinical aspects and management of fibromyalgia syndrome. Ann Acad Med Singapore. 2009;38(11):967-73.
8. Altan L, Korkmaz N, Bingol U, Gunay B. Effect of Pilates training on people with fibromyalgia syndrome: a pilot study. Arch Phys Med Rehabil. 2009;90(12):1983-8.
9. Shuster J, McCormack J, Pillai Riddell R, Toplak ME. Understanding the psychosocial profile of women with fibromyalgia syndrome. Pain Res Manag. 2009;14(3):239-45.
10. Buskila D. Developments in the scientific and clinical understanding of fibromyalgia. Arthritis Res Ther. 2009;11(5):242-9.
11. Understanding fibromyalgia and its related disorders. Prim Care Companion J Clin Psychiatry. 2008;10(2):133-44.
12. Queiroz LP. Worldwide epidemiology of fibromyalgia. Curr Pain Headache Rep. 2013;17(8):356.
13. Berger A, Sadosky A, Dukes EM, Edelsberg J, Zlateva G, Oster G. Patterns of healthcare utilization and cost in patients with newly diagnosed fibromyalgia. Am J Manag Care. 2010;16(5 Suppl):S126-37.
14. Perrot S, Schaefer C, Knight T, Hufstader M, Chandran AB, Zlateva G. Societal and individual burden of illness among fibromyalgia patients in France: association between disease severity and OMERACT core domains. BMC Musculoskelet Disord. 2012;13:22.
15. Senna ER, De Barros AL, Silva EO, Costa IF, Pereira LV, Ciconelli RM, et al. Prevalence of rheumatic diseases in Brazil: a study using the COPCORD approach. J Rheumatol. 2004;31(3):594-7.
16. Santos AM, Burti JS, Lopes JB, Scazufca M, Marques AP, Pereira RM. Prevalence of fibromyalgia and chronic widespread pain in community-dwelling elderly subjects living in São Paulo, Brazil. Maturitas. 2010;67(3):251-5.
17. Assumpção A, Cavalcante AB, Capela CE, Sauer JF, Chalot SD, Pereira CA, et al. Prevalence of fibromyalgia in a low socioeconomic status population. BMC Musculoskelet Disord. 2009;10:64.
18. Ambrose KR, Golightly YM. Physical exercise as non-pharmacological treatment of chronic pain: Why and when. Best Pract Res Clin Rheumatol. 2015;29(1):120-30.
19. Macfarlane GJ, Kronisch C, Dean LE, Atzeni F, Hauser W, Flub E, et al. EULAR revised recommendations for the management of fibromyalgia. Ann Rheum Dis. 2016. [Epub ahead of print].
20. Vural M, Berkol TD, Erdogdu Z, Pekedis K, Kuçukserat B, Aksoy C. Evaluation of the effectiveness of an aerobic exercise program and the personality characteristics of patients with fibromyalgia syndrome: a pilot study. J Phys Ther Sci. 2014;26(10):1561-5.
21. Nijs J, Van Houdenhove B. From acute musculoskeletal pain to chronic widespread pain and fibromylagia: application of pain neurophysiology in manual therapy practice. Man Ther. 2009;14(1):3-12.
22. Segal NA, Hein J, Basford JR. The effects of Pilates training on flexibility and body composition: an observational study. Arch Phys Med Rehabil. 2004;85(12):1977-81.
23. Eyigor S, Karapolat H, Yesil H, Uslu R, Durmaz B. Effects of Pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. Eur J Phys Rehabil Med. 2010;46(4):481-7.
24. Johnson EG, Larsen A, Ozawa H, Wilson CA, Kennedy KL. The effects of Pilates-based exercise on dynamic balance in healthy adults. J Bodywork Mov Ther. 2007;11:238-42.
25. Bennett RM, Bushmakin AG, Cappelleri JC, Zlateva G, Sadosky AB. Minimal clinically important difference in the fibromyalgia impact questionnaire. J Rheumatol. 2009;36(6):1304-11.
26. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the Multicenter Criteria Committee. Arthritis Rheum. 1990;33(2):160-72.
27. Carrillo-de-la-Peña MT, Triñanes Y, González-Villar A, Romero-Yuste S, Gómez--Perretta C, Arias M, et al. Convergence between the 1990 and 2010 ACR diagnostic criteria and validation of the Spanish version of the Fibromyalgia Survey Questionnaire (FSQ). Rheumatol Int. 2015;35(1):141-51.
28. Marques AP, Santos AM, Assumpção A, Matsutani LA, Lage LV, Pereira CA. Validação da versão brasileira do Fibromyalgia Impact Questionnaire (FIQ). Rev Bras Reumatol. 2006;46(1):24-31.
29. Gorenstein C, Andrade L. Validation of a Portuguese version of the Beck Depression Inventory and the State-Trait Anxiety Inventory Brazilian subjects. Braz J Med Biol Res. 1996;29(4):453-7.
30. Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clincal anxiety: psychometric properties. J Consult Clin Psychol. 1988;56(6):893-7.
31. Creamer M, Foran J, Bell R. The Beck Anxiety Inventory in a non-clinical sample. Behav Res Ther. 1995;33(4):477-85.
32. Dworkin RH, Turk DC, McDermott MP, Peirce-Sandner S, Burke LB, Cowan P, et al. Interpreting the clinical importance of group differences in chronic pain clinical trials: IMMPACT recommendations. Pain. 2009;146(3):238-44.
33. Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
34. Maquet D, Demoulin C, Croisier JL, Crielaard JM. Benefits of physical training in fibromyalgia and related syndromes. Ann Readapt Med Phys. 2007;50(6):356-62.
35. Martinez JE, Fujisawa RM, Carvalho TC, Gianini RJ. Correlação entre a contagem dos pontos dolorosos na fibromialgia com a intensidade dos sintomas e seu impacto na qualidade de vida. Rev Bras Reumatol. 2009;49(1):32-8.
36. Moyano S, Kilstein JG, Alegre de Miguel C. New diagnostic criteria for fibromyalgia: here to stay? Reumatol Clin. 2015;11(4):210-4. English, Spanish.
37. Vianna Paulo DL, Yassuda MS. The relation between memory complaints in the elderly and education, cognitive performance, and symptoms of depression and anxiety. Rev Psiquiatr Clín. 2010;37(1):23-6.
38. Alves de Araújo ME, Bezerra da Silva E, Bragade Mello D, Cader SA, Shiguemi Inoue Salgado A, Dantas EH. The effectiveness of the Pilates method: reducing the degree of non-structural scoliosis, and improving flexibility and pain in female college students. J Bodyw Mov Ther. 2012;16(2):191-8.
39. Kuo YL, Tully EA, Galea MP. Sagittal spinal posture after Pilates-based exercise in healthy older adults. Spine. 2009;34(10):1046-51.
40. Wells C, Kolt GS, Marshall P, Bialocerkowski A. Indications, benefits, and risks of Pilates exercise for people with chronic low back pain: a Delphi survey of Pilates-trained physical therapists. Phys Ther. 2014;94(6):806-17.
41. Yang YM, Yang HB, Park JS, Kim H, Lee SW, Kim JH. Spontaneous diaphragmatic rupture complicated with perforation of the stomach during Pilates. Am J Emerg Med. 2010;28(2):259.e1-3.
42. Fong TC, Hoffmann B. Images in clinical medicine. Disappearance of a breast prosthesis during Pilates. N Engl J Med. 2011;365(24):2305.
43. McCarney R, Warner J, Iliffe S, van Haselen R, Griffin M, Fisher P. The Hawthorne Effect: a randomised, controlled trial. BMC Med Res Methodol. 2007;7:30.
44. Moore RA, Straube S, Paine J, Phillips CJ, Derry S, McQuay HJ. Fibromyalgia: moderate and substantial pain intensity reduction predicts improvement in other outcomes and substantial quality of life gain. Pain. 2010;149(2):360-4.