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The effectiveness of 12 weeks of Pilates intervention on disability, pain and kinesiophobia in patients with chronic low back pain: a randomized controlled trial

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Abstract

Objective: To assess the effectiveness of 12 weeks of Pilates practice on disability, pain and kinesiophobia in patients with chronic non-specific low back pain.
Design: This is a randomized controlled trial.
Setting: This study was conducted in the university laboratory.
Subjects: A total of 64 participants with chronic non-specific low back pain were included.
Interventions: Participants were randomly allocated to intervention group consisted in Pilates intervention during 12 weeks ($n = 32$) or control group who received no treatment ($n = 32$).
Main measures: Disability, pain and kinesiophobia were assessed by Roland Morris Disability Questionnaire, visual analogue scale and Tampa Scale of Kinesiophobia, respectively. Measurements were performed at baseline, at 6 and 12 weeks after study completion.
Results: There were significant differences between groups with observed improvement in Pilates intervention group in all variables after treatment ($P < 0.001$). Major changes on disability and kinesiophobia were observed at six weeks of intervention with no significant difference after 12 weeks ($P < 0.001$). Mean changes of the intervention group compared with the control group were 4.00 (0.45) on the Roland Morris Disability Questionnaire and 5.50 (0.67) in the Tampa Scale of Kinesiophobia. Pain showed better results at six weeks with a slightly but statistically significant improvement at 12 weeks with Visual Analogue Scale scores of 2.40 (0.26) ($P < 0.001$).
Conclusion: Pilates intervention in patients with chronic non-specific low back pain is effective in the management of disability, pain and kinesiophobia.

Keywords

Pilates, chronic low back pain, kinesiophobia, therapeutic exercise

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Introduction

Therapeutic exercise is considered one of the most effective treatment options in the improvement of pain and disability, associated with chronic non-specific low back pain.[1,2] Among these exercise modalities, the Pilates method has been reported to be effective in the management of chronic low back pain and has been widely recommended by healthcare providers.[3] The combination of Pilates training with physical therapy intervention in patients with chronic low back pain has proved to be superior to physical therapy alone in the long term.[4] Pilates principles include motor control, deep trunk muscle activation and pelvic floor muscles activation,[5] which may play an important role in the improvement of pain and disability in this population group. A proper monitoring of the muscular pattern activation and the evaluation of deep trunk muscle thickness would provide additional data to elucidate the mechanism of action due to Pilates intervention.

Although Pilates method has been deemed to be effective in previous research, some studies present limitations such as small sample size, the absence of control group, high rate of drop-out or inaccurate description of the intervention.[6] A recent systematic review found that there was low to moderate quality evidence that Pilates is more effective than minimal intervention for those with chronic low back pain with contradictory findings.[6] The role of Pilates principles application and its influence in the management of pain and disability remains unclear.

Therefore, the aim of this study was to assess the effectiveness of 12 weeks of Pilates intervention on pain, function, kinesiophobia and deep trunk muscle thickness in patients with chronic non-specific low back pain.

Methods

This is a single-blind randomized controlled trial conducted at the physiotherapy laboratories of the University of Jaén. Recruitment process was based on informative panels located in the University campus and Medical Centers of Jaén (Spain). Patients from the university and general population who responded to the announcement were screened by an expert clinician and invited to be enrolled in the study if the following inclusion criteria were meet: age between 18 and 50 years; suffering from low back pain for at least three months; absence of radiculopathy or other damages to the spine such as fractures, stenosis or tumors; not habitual Pilates practitioners; not receiving physical therapy during the trial or immediately prior thereto; and enough physical autonomy to participate in the physical activities required by the study.

This study was registered (NCT: NCT02371837) and was approved by the Human Ethics Committee of the University of Jaén and meets the CONSORT (Consolidated Standards of Reporting Trials) statement and guidelines.[7] Patients who met the inclusion criteria and accepted to be enrolled in the study were randomly allocated into experimental and control groups. Participants were randomized into Pilates or control group using sealed opaque envelopes that were created at each institution prior to the initiation of the investigation by an independent researcher not involved with the intervention in a 1:1 ratio.

Participants were evaluated at three different times during the intervention in the physiotherapy laboratory by an independent assessor blinded to the allocation and intervention. Outcomes measured were disability, pain, kinesiophobia and muscular thickness and were assessed at baseline prior to the beginning of the intervention, after 6 and 12 weeks of treatment.

Disability was assessed using the Roland Morris Disability Questionnaire, a short and simple measure with contrasted validity, reliability and responsiveness. The questionnaire is a 24-item scale, the scores of which range from 0 (no disability) to 24 (high disability).[8–10]

Pain was measured using a visual analogue scale. The visual analogue scale consists of a 10-cm line, with the left extremity representing (absence of pain) and the right extremity indicating (great pain). Participants were asked to indicate in the scale their current level of pain, higher values being related to more intense pain.[11]

Fear of movement/injury or reinjury was assessed using the Spanish version of the Tampa Scale of

Kinesiophobia, a 17-item with scores ranged from 17 (absence of fear) to 68 (highest fear).[12,13] Tampa Scale of Kinesiophobia has been reported to correlate with the Roland Morris Disability Questionnaire,[14] the primary outcome measure of this study, and has presented good reliability in patients with chronic non-specific low back pain.[15]

Transversus abdominis activation was assessed to evaluate the possible change in the deep trunk muscle function using a real-time ultrasound scanning, MyLab 25 Gold (Esaote, Inc., Paris, France) with a 60-mm, 5-MHz curvilinear array in brightness mode at rest and during abdominal drawing-in maneuver. The transversus abdominis was tested in the supine hook-lying position (subject lying supine, with feet placed on the table, hips flexed to visually approximated 45° and knees to 90°). The thickness of transversus abdominis was defined as the distance between the upper and lower borders of the fascia of the transversus abdominis and the percentage change in thickness was calculated.[16]

Patients assigned to experimental group were included in a Pilates intervention which consisted of two sessions per week of 50 minutes during 12 weeks. The Pilates sessions were conducted by an expert Pilates physiotherapist instructor with 10 years of experience. The intervention was divided in three different parts. Each session start with a warm-up with breathing exercises, pelvis tilt centering, deep trunk and pelvic floor muscles activation and joint mobility. The principal part of the session consisted in strength and flexibility exercises involving the trunk, upper and lower limbs. Finally, a cool down section with some stretching exercises was conducted. All the exercises proposed by the instructor could be performed at different difficulty levels (basic, intermediate and advanced) in order to be adapted to patients' physical condition. A more detailed description of the protocol can be found in Table 1. In order to collect any adverse event both during and after the Pilates session, patients were instructed to record any discomfort in the given booklet at the beginning of the study.

Patients who were allocated to control group received a booklet with chronic non-specific low back pain information, to minimize potential drop-out and disappointment with not receiving any treatment. Patients of the control group who attended to the assessment session were offered to be incorporated to the same Pilates protocol performed by the intervention group after study completion.

Table 1. Intervention program.

Pilates Mat
1. Warm-ups
2. Single leg stretch
3. Double leg stretch
4. Criss-cross
5. Single straight leg
6. Roll up
7. Rolling
8. Side kick: front/back
9. Side kick: small circles
10. Spine twist
11. Rowing 3
12. Rowing 4
13. Pull straps 1
14. Pull straps 2
15. Swimming
16. Teaser 1
17. Leg pull back
18. Leg pull front
19. Mermaid
20. Rolling down
21. Cool down

Sample size estimation was designed to have at least 80% power to detect a 2.5-point between-group difference in the scores of the primary outcome measure, the Roland Morris Questionnaire. Sample size calculation was performed with ENE 3.0 (GlaxoSmithKline, Brentford, UK) for a common standard deviation of 3.7 points in the Roland Morris Disability Questionnaire taking as a reference the data reported by Morton;[17] using a two-group one-tailed *t* test with 80% power at the 0.05 level required 28 subjects per group. Considering a drop-out rate of 15%, the final sample population was 32 patients per group. Data were analyzed using the SPSS version 23.0 (SPSS Inc., Chicago, IL, USA) statistical package. Distributions were checked using Kolmogorov–Smirnov test to ensure that parametric assumptions were met. In order to

compare the variables between groups, Student *t* test or non-parametric equivalent, Mann–Whitney *U* test, was used. To assess differences between evaluation times within groups, the one-way analysis of variance (ANOVA) with repeated measures or the non-parametric alternative, the Friedman test, was used. Chi-square was used to compare descriptive data of the participants.

Results

A total of 64 patients (32 Pilates group and 32 control group) were enrolled in the study (Figure 1). All participants completed the study in the experimental group and two patients included in the control group were excluded to loss the assessment session. The sociodemographic data of Pilates and control group participants are shown in Table 2. No significant difference was found among pre-intervention characteristics of the control and the experimental groups. The weight was similar between the groups in the three moments where sampled; however, the body mass index was significantly different between the groups in the pre-intervention ($P = 0.020$), but not 6 or 12 weeks post-intervention.

Table 3 shows the pre- and post-intervention (6 and 12 weeks) outcome measures of transversus abdominis thickness, disability, pain and kinesiophobia. None of the variables showed differences between groups before the intervention. However, all variables, except the transversus abdominis, improved significantly in the group of Pilates with respect to control group, both at 6 to 12 weeks post-intervention. In the group of Pilates, all measures at six weeks improve their values respect to pre-intervention and the improvement is maintained or is higher at 12 weeks post-intervention.

Discussion

The main finding of this study was that 12 weeks of Pilates intervention was effective in reducing pain intensity and improving disability, fear of movement and deep trunk muscle thickness in patients with chronic non-specific low back pain. There were reported no adverse events during the intervention in the Pilates group whose participants showed high adherence to treatment with no drop-outs.

Pilates group showed an improvement on disability and function with a significant change in the Roland Morris Disability Questionnaire score from baseline to 6 and 12 weeks, with no changes observed in the control group with an $R^2 = 0.179$; $P < 0.001$. The effectiveness of Pilates in the management of patients with chronic non-specific low back pain has been addressed by several studies.[18–22] Our results agree with previous reported data where Pilates has been deemed to be superior to no treatment or minimal intervention in this population group.[4,19,20] It was observed a change of five points in the Roland Morris Disability Questionnaire after 12 weeks of Pilates intervention. These results are consistent with the existing research of previous studies using the same outcome measure but showing greater improvement.[3,21,22] The longer duration of the present Pilates intervention may be one factor that explains the better results obtained in disability and function. This hypothesis has been advocated by Natour et al.,[3] who suggested that better scores could be related to longer intervention time. However, in our study, major change on disability was obtained after six weeks of Pilates intervention, with no observed within-group change between 6 and 12 weeks. Thus, motor control learning skills and Pilates methodology may play an important role in the Pilates intervention effectiveness.

Regarding pain perception, it was observed a significant improvement on pain in the Pilates group with no change in the control group from baseline to 6 and 12 weeks, respectively, $P < 0.001$. Our results in the intervention group, ranged from 4.70 (4.09–5.05) at baseline to 1.95 (1.81–2.37) at the end of the intervention. In contrast to the obtained results on disability, it was observed a significant and progressive improvement from 6 to 12 weeks of intervention. This may indicate that longer intervention could be related to pain perception improvement, although function did not follow this pattern. As with disability results, self-reported pain improvement was greater than those reported by similar

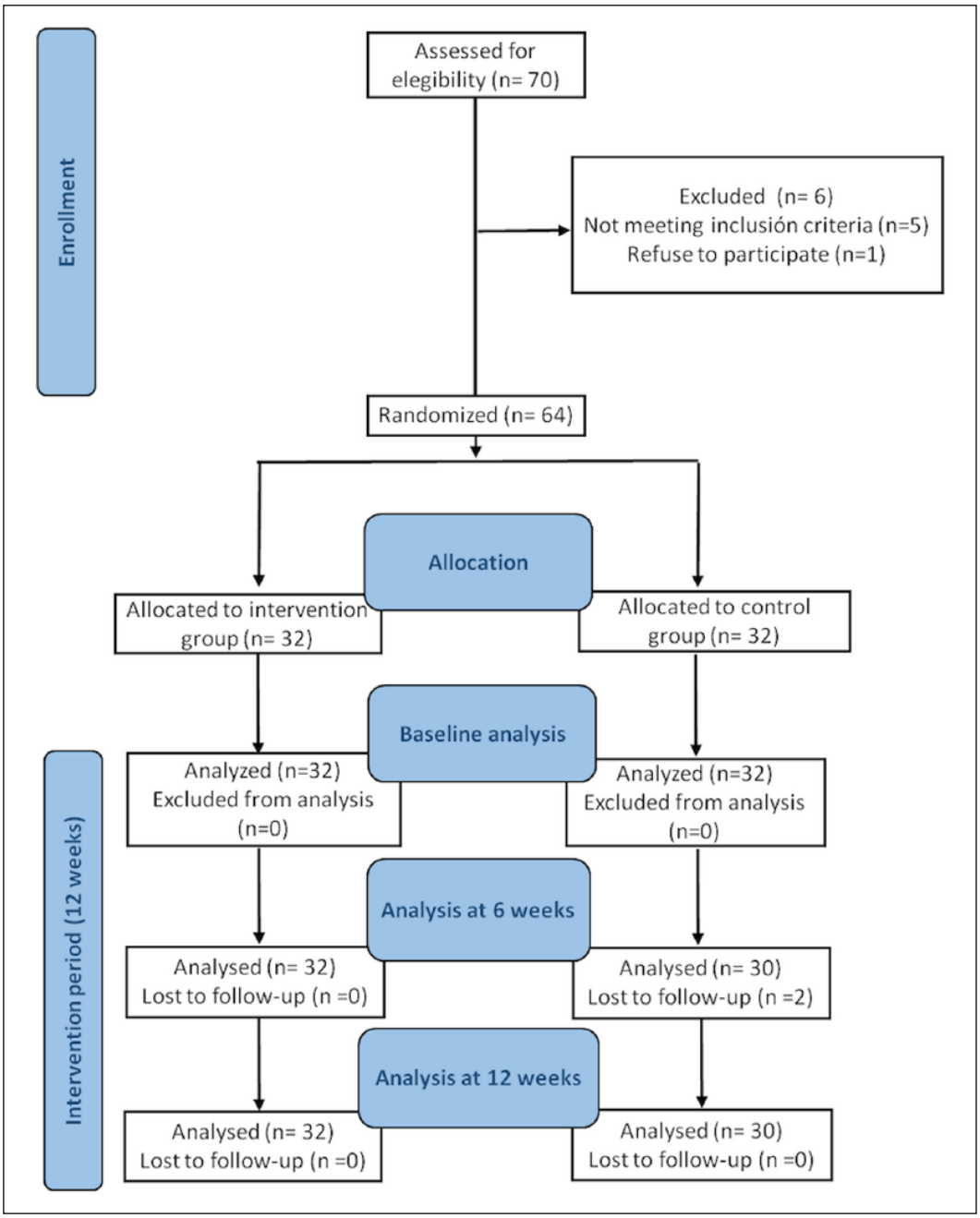

Figure 1. Flowchart of the study.

studies.[20–24] A possible explanation may be that the management of the deep trunk muscle activation due to Pilates practice could improve the perception of pain. These results agree with the reported data of Ferreira et al.,[25] who suggested that pain may be responsible of the onset of deep trunk muscle dysfunction. The improvement observed on pain and transversus abdominis in this study may contribute to support this hypothesis. With regard to this statement, it is widely extended among Pilates literature that deep trunk muscle activation is related to the improvement on pain and disability.[26] Some authors have concluded that the improvement of deep trunk

Table 2. Baseline characteristics of participants at all evaluation times.

		Pilates (PG) $n=32$			Control (CG) $n=30$			*P*-value PG versus CG
		Mean	SD	*pT*	Mean	SD	*pT*	
Gender (female/male) (%)		21/11			20/10			0.876
Age (years)		37.9	8.2		35.6	6.7		0.220
Height (m)		1.68	0.09		1.71	0.1		0.237
Weight[a] (kg)	Pre	58	58.83–68.17		59	57.57–62.63		0.989
	6w	56	57.34–65.47	a	59	57.39–63.01	ns	0.636
	12w	55.5	56.37–64.5	a, b	59	58.02–62.91	ns	0.277
BMI (kg/m^2)	Pre	22.38	2.71		20.77	2.57		0.020
	6w	21.69	2.43	ns	20.78	2.59	ns	0.156
	12w	21.34	2.42	ns	20.89	2.54	ns	0.482
Occupational status (%)	Primary	7	21.8		5	16.6		0.425
	Secondary	12	37.5		14	46.6		
	University	13	40.7		11	36.6		
Marital status (%)	Single	8	25		6	20		0.326
	Married	16	50		17	56.6		
	Divorced	8	25		7	23.3		

BMI: body mass index; PG: experimental Pilates group; CG: control group, control; SD: standard deviation; CI: confidence interval; Pre: pre-intervention; 6w: six weeks post-intervention; 12w: 12 weeks post-intervention; *pT: P*-values between pre-6w-12w evaluation times.

a: $P<0.05$ with respect to Pre; b: $P<0.05$ with respect to 6w; ns: not significant.

[a]Non-normal distributed data, values are expressed as median and 95% CI.

muscle activation due to Pilates practice could be an important component in achieving positive results in patients with chronic non-specific low back pain.[3,4,26] Nevertheless, until recently, there is no evidence about the improvement on deep trunk muscle activity after Pilates training. In our study, transversus abdominis thickness was assessed and was observed major change after six weeks in the Pilates group with a more slightly but constant improvement during the rest of the intervention until the completion of the study after 12 weeks. Control group did not present any significance difference from baseline to 6 and 12 weeks; $P<0.001$.

Kinesiophobia is an important variable in patients with chronic non-specific low back pain because of its relationship with disability and symptom perpetuation.[27] The lack of activity due to fear of movement, may induce muscle atrophy and therefore worsening of symptoms.[27] Some studies have reported the benefit of Pilates intervention in the improvement of kinesiophobia.[20,24,26] However, to our knowledge, only Da Luz Jr et al.[20] and Miyamoto et al.[24] have studied the influence of Pilates on kinesiophobia in patients with chronic non-specific low back pain with contradictory findings. Our results support the positive findings reported by Da Luz Jr et al.20 in contrast with Miyamoto et al.,[24] whose results showed no change after the intervention. The improvement on pain and disability could be related to an increased physical activity which may have a positive influence on kinesiophobia. Fear avoidance beliefs about physical activity may lead in decreased neuromuscular control of the deep trunk muscle activation which has been reported to be related to chronic low back pain. Thus, the improvement of patient's confidence and their involvement in physically demanding task could contribute to a better neuromuscular function.

Following the recommendation of a recent systematic review about the effectiveness of

Table 3. Pre- and post-intervention measures of transversus abdominis thickness, disability, pain and kinesiophobia at all evaluation times.

		Pilates (PG) *n* = 32		Control (CG) *n* = 30		Difference (CG-PG)		*P*-value
		Median	95% CI	Median	95% CI	Mean	SD	PG versus CG
RM[a]	Pre	10.00	(8.31–9.94)	9.00	(8.87–10.20)	–1.00	0.52	0.716
	6w	5.00	(4.15–5.35)	9.00	(8.61–9.99)	4.00	0.45	<0.001
	12w	5.00	(3.51–4.87)	9.00	(8.80–10.13)	4.00	0.47	<0.001
VAS[a]	Pre	4.70	(4.09–5.05)	5.15	(4.07–5.21)	0.45	0.37	0.789
	6w	2.05	(2.06–2.66)	4.85	(4.02–5.13)	2.80	0.31	<0.001
	12w	1.95	(1.81–2.37)	4.35	(4.31–5.21)	2.40	0.26	<0.001
Tampa[a]	Pre	34.50	(33.61–35.76)	34.00	(32.64–35.16)	–0.50	0.81	0.269
	6w	27.50	(26.32–28.68)	33.00	(31.70–33.10)	5.50	0.67	<0.001
	12w	27.50	(26.32–28.68)	32.50	(32.18–34.35)	5.00	0.79	<0.001
TrAR[a]	Pre	5.75	(5.30–5.86)	6.25	(5.45–6.19)	0.50	0.23	0.131
	6w	6.00	(5.69–6.16)	6.15	(5.51–6.21)	0.15	0.20	0.672
	12w	6.00	(5.68–6.09)	6.20	(5.43–6.09)	0.20	0.19	0.888
TrAC[a]	Pre	6.95	(6.32–6.88)	7.00	(6.41–7.12)	0.05	0.22	0.198
	6w	8.25	(7.94–8.56)	7.10	(6.41–7.15)	–1.15	0.24	<0.001
	12w	9.00	(8.51–9.41)	6.90	(6.33–7.04)	–2.10	0.28	<0.001
TrA%[a]	Pre	19.16	(15.95–21.57)	15.15	(13.57–20.65)	–4.01	2.21	0.317
	6w	38.85	(35.01–44.76)	15.05	(13.64–18.46)	–23.80	2.66	<0.001
	12w	56.59	(46.42–58.71)	16.23	(12.92–20.17)	–40.36	3.49	<0.001

TrAR: transversus abdominis thickness in relaxation; TrAC: transversus abdominis thickness in activation; TrA%: TrA activation; RM: Roland Morris disability test; VAS: visual analogue scale of pain; Tampa: Tampa Scale of Kinesiophobia; PG: experimental Pilates group; CG: control group, control; CI: confidence interval; Pre: pre-intervention; 6w: six weeks post-intervention; 12w: 12 weeks post-intervention.

[a]Non-normal distributed data, values are expressed as median and 95% CI.

Pilates intervention in patients with chronic non-specific low back pain,[6] the authors have sought to avoid some methodological issues observed in previous research such as the presence of a control group, concealed allocation or assessors blinding. This study yielded new results regarding the importance of deep trunk muscle training in the improvement of chronic low back pain. However, additional research is needed to confirm the present findings and for a better understanding of the influence of muscle training approach in this population group. Moreover, although the use of ultrasound measurement is well-documented and reported good reliability and validity, the inter-examiner reliability could be considered as a risk of bias.[25] Conflicting results showed in previous research regarding Pilates effectiveness could benefit from a better understanding of muscle activity changes due to Pilates training.

Pilates group participants experienced a noticeable improvement in all outcome measures after 12 weeks of intervention. The effectiveness of Pilates in the management of patients with chronic low back pain together with the absence of adverse events and the rapid improvement observed in the intervention group suggests that Pilates is a valuable treatment option that could be incorporated during the rehabilitation process in this population group. Nevertheless, a follow-up period to observe the long-term effects of the Pilates intervention is required. The evaluation of the achieved results over time will enable researchers to know more about how these

improvements are maintained to prevent relapses and to develop a therapeutic protocol for patients with chronic low back pain.

Clinical Messages

- The Pilates method was effective in improving disability, pain and kinesiophobia in patients with chronic non-specific low back pain.
- Transversus abdominis thickness increased after 12 weeks of Pilates intervention.
- No adverse events or symptoms aggravation were observed during the intervention.

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