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Research Article

Comparison of low back mobility and stability exercises from Pilates in non-specific low back pain: A randomized controlled trial

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Abstract

Objectives: Compare the effects of the low back mobility and stability exercises from Pilates Method on low back pain, disability and movement functionality in individuals with non-specific chronic low back pain.

Methods: 28 participants were randomized into two exercise protocol from Pilates methods, one focusing on low back stability and other on low back mobility. Low back pain (visual analogic scale), low back disability (Oswestry) and movement functionality (7 functional movement tasks) were evaluated before and after 10 sessions of Pilates exercise by the same trained assessor. A mixed designed ANOVA with two factors was used.

Results: The results of the study showed that there was a significant improvement to the pain, disability and movement functionality after the intervention regardless the group and it wasn't found significant interaction.

Conclusions: Regardless the exercise protocols both improved all outcomes for individuals with non-specific chronic low back pain. Also, there is no difference between focus on mobility or stability in the application of Pilates exercises for those outcomes therefore, the indication of one exercise protocol or another may fall within the preference of the instructor or practitioner/patient.

Background

Pilates method has gained importance in recent years, since it can be used as an important tool for the rehabilitation of various musculoskeletal disorders [1], including non-specific chronic low back pain [2]. This method has a great emphasis on the strengthening core muscles and motor control [3], moreover it was found to be strong for improving spine mobility and muscular endurance [1].

Despite the fact that a recent review suggested that there is no evidence to suggest one form of exercise is better than another for the treatment of chronic low back pain [4], there is still a discussion about whether stability or mobility of the lumbar spine generates better results, both in performance and rehabilitation [5]. Popular core stability exercise programs commonly focus on bracing or activating the core muscles that are believed to support and stabilize the spine [6]. However, biomechanically, only low levels of muscle contraction are needed to stabilize the spine during daily activities, further, individuals with chronic low back pain usually have increased levels of abdominal and lumbar muscle activity and the approach to increase the muscular demand during daily activities might be create a fear of movement, catastrophizing, muscle fatigue, more disability and pain [7]. Exercises focusing on spine mobility for individuals with low back pain have been

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historically prescribed after the American Medical Association and the American Academy of Orthopedic Surgeons suggested that measure spine mobility is a good approach to measure low back disability [8]. However, there are a few suggestions that the mobility of the lumbar spine seems to be poorly associated with movement functionality and low back disability [5], presenting poor or nonexistent relationship [9].

Most of Pilates practitioners still have a focus on biomechanical impairments to treat chronic low back pain, and they question whether better outcomes can be reach for chronic low back pain individuals if they focus on spine mobility or stability [1,6,10]. Therefore, the aim of this study is to compare two exercises protocols from Pilates method, one focusing one spine mobility and other on spine stability, on low back pain, disability and movement functionality in individuals with non-specific chronic low back pain. Our hypothesis is that both exercises programs will equally improve pain and disability, since recent evidence suggested that one form of exercise is no better than another for treating chronic low back pain.

Methods/Design

Study design and ethical approval

This study was designed as a randomized, triple-blind, clinical trial divided into two groups, Pilates Mobility and Pilates Stability with an allocation ratio of 1:1. And it was written in accordance with the Consort 2010 instructions [11,12] and TIDieR checklist [13].

This study protocol was approved by the Ethics Committee in Research of the Federal University of Rio Grande do Sul (protocol number 66604917.1.0000.5347 in 08/05/2017), also registered in an international clinical trial registry, clinicaltrials.gov(protocol number NCT03188003) and it was previously published [14]. All participants signed the informed consent term, prepared in compliance with the Declaration of Helsinki of the World Health Organization. The intervention was conducted in two Pilates studios, both of them with previous written authorization.

Participants

Request for participants was published in social media network and also placed on Pilates Studios. All respondents were informed of all the study procedures, and those that were interested, was provided with a brief introduction about the selection process. Detailed information about participants was given in the eligibility criteria.

Inclusion criteria were individuals of both genders with age between 21 and 40 years old; presenting with low back pain for at least 3 months; low back pain disability equal or greater than 10% measured with the Oswestry Disability Index [15,16]; be able to perform the Pilates exercise interventions.

Exclusion criteria were any contraindications for Pilates exercise; low back pain irradiated to lower limb; any neurological disorder to lower limb(motor, reflex or sensory disorder); medical diagnosis of spondylolisthesis; spinal stenosis; inflammatory or metabolic disease; cancer; childbirth in the previous 6 months; be in treatment for low back pain in the same period of the interventions; miss two followed sessions or three alternately without retrieving them in the same week or not participate in the assessments.

Interventions

This trial had two distinct interventions, both exclusive with Pilates method and both protocols was already published [14]. Pilates Stability group focused on exercises that promote low back stability, avoiding perform movements that improve spine mobility. The Pilates Mobility group focused on exercises that promote spine mobility, avoiding perform movements that improve spine stability. Both groups performed the interventions for 10 sessions with up to four participants per cluster of participants, twice a week but not in consecutive days. Each session lasted approximately 50 minutes.

Avoiding an instructor dependent result, the intervention was held by two independent Pilates instructors, graduated in Physical Therapy or Physical Education. The participants were divided so that each instructor applies both interventions (mobilization and stabilization Pilates) in half of the people of each group.

Both the Pilates Mobility group and the Pilates Stability group performed specific Pilates method exercises (Table 1) in all the moments of the session, with simple adaptations according to the focus of the exercise [17-19]. A better description of those exercises is already published [14].

Table 1: Mobility and Stability Pilates exercises.

Mobility Pilates exercises	Stability Pilates exercises
1. The Hundred	1. The Hundred
2. Shoulder Bridge	2. Shoulder Bridge
3. Roll Up	3. Single Leg Circle
4. Swan	4. Footwork - Toes, Arch and Heel
5. Diamond Press	5. Standing Leg Pump - Front
6. Cat Stretch	6. Arms Circles
7. Mermaid Sitting	7. Long stretch
8. Hamstring Press	8. Chest Expansion - Sitting
9. Standing Roll Down	9. Double Straight Leg Stretch
10. Spine Stretch Forward	10. Side Kick - Small Circles
11. Spine Twist	11. Bent Knee Fallout
12. Circles on The Wall	12. Circles on The Wall

Outcomes

The primary outcome was low back pain disability measured with Oswestry Disability Index (ODI) previous validated and adapted version for Portuguese language and culture [16]. The questionnaire includes ten questions of six alternatives. The first question evaluates the low back pain intensity and the nine following ones evaluate the disability caused by the low back pain in several diaries tasks like walking, lifting weight, social life and sitting [15].

The secondary outcomes was pain measured with a visual analogic scale(VAS) which has a simple and quick application, and also, being considered as an acceptable tool to measure pain intensity [20]. This scale is highly used in researches involving low back pain [21] and consists in a validated instrument with a linear visual scale that goes from no pain to pain as bad as could possibly be [22].

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The functional ability (FMS) was also assessed to identify movement restriction and limitation with seven movements tasks [23,24]. Each of the tasks have a score that range from three, which is a participant with a very good functional ability, to zero when there is presence of pain during the task. The total score is 21 and is given by the sum of the seven movements tasks and when one of the tasks is performed bilaterally, the score summed is the lowest [23,24]. The movement tasks are the Deep Squad, Hurdle step, In-line lunch, Shoulder mobility, Active straight leg raise, Trunk stability push-up and Rotatory stability. All of those tasks evaluate the mobility and stability capacity of different joints of the human body.

This tool to assess functional ability have a moderated evidence of good intra- and inter-evaluator reproducibility [25]. All outcome evaluations were conducted identically before and after the 10 sessions of Pilates exercises for both groups by the same trained assessor. No change was made for any of those outcomes during the trial [14].

Sample Size

The sample size was determined using the software G*Power 3.1, which used the Factorial ANOVA with a power of 80% a significance level of 0.05; The F effect size considered was 0.385 based on previous Oswestry Disability Index and Pilates studies [26]. Therefore, the required sample size for this study is 28 participants randomly assigned in two different treatments.

Randomization

Randomization was made by cluster. After establishing the predetermined hour of intervention for the group of four participants, the class of participant was randomized in one of the two interventions (Pilates Mobility and Pilates Stability) according to the sequence of codes generated randomly by a randomization website. The following order generated with the group was informed by phone call at the time of class intervention.

Blinding

The evaluation team consisted of five collaborators, two performed the interventions with Pilates, one evaluated the outcomes, one randomized the participants and other performed the statistical analysis. All participants were informed that they would be blindly allocated to one of the two Pilates exercise protocols, thus the participants were blinded. All the outcome assessments were conducted by the same collaborator who did not know which intervention belongs to the participant and the Pilates instructors did not participated in any evaluation process. Another collaborator performed the statistical analyses without knowing which intervention was conducted by each group. Hence, the participant, the outcome assessor and the statistical analysis was blinded.

Statistical methods

The statistical analyses were performed with the software SPSS 22.0. The normality was tested with the inferential test Shapiro-Wilk and the data were presented as parametric. The homogeneity and sphericity were verified with Levene's and Mauchly's test respectively and correction on degrees of freedom was made when necessary.

For the comparison tests, it was used mixed designed ANOVA with two factors, main factor intervention (Mobility and Stability Pilates) and main factor time (pre- and post-intervention) for each outcome. No post hoc tests were necessary. The effect size was calculated through partial eta squared(η^2), the statistical analysis was held with the intention-to-treat concept and the significance adopt defined is 0.05 [27].

Results

In this study, 30 participants were evaluated and two were excluded because they presented radiculopathy. Therefore, 28 participants were equally randomized into two groups, and two participants quitted the Pilates Stability Group intervention because of their schedule time (Figure 1). Regardless the participant quit all 14 participants were analyzed with an intention-to-treat concept using the pre-intervention outcomes values as the post-intervention values. The recruitment and intervention were carried out in June through November 2017.

In the baseline data, there were no statistical difference between groups in any of the anthropometric characteristics. Also, there were no significant difference for the baseline variables such as disability, pain or movement functionality before the intervention starts showing a homogeneity between groups (Table 2).

Regarding the primary outcome, low back disability, there was a significant reduction in the Oswestry Disability Index to the main factor time, from pre-intervention 19.9(1.3) % to post intervention 4.9(0.7) % with a high effect size of 82%. There was no significant effect for neither the main factor group or the interaction between time and group (Table 3).

For pain assessment with the Visual Analogic Scale there was a significant reduction regarding the main factor time, from pre-intervention 36.9(4.8) mm to post intervention 13.3(3.1) mm with an effect size of 32%. There was no significant effect for neither the main factor group or the interaction between time and group (Table 4).

There was a significant increase regarding the movement functionality for the main factor time, increasing the score from pre-intervention 11.1(0.6) to 15.4(0.6) in the post intervention assessment, with an effect size of 66%. There was no significant effect for neither the main factor group or the interaction between time and group (Table 5).

Discussion

In our knowledge this study was the first study comparing the effects of Pilates exercise programs emphasizing mobility and stability of the spine in non-specific low back pain. Rarely low back pain can be specified with a specific cause; the reason is because low back pain has multifactorial causes by a range

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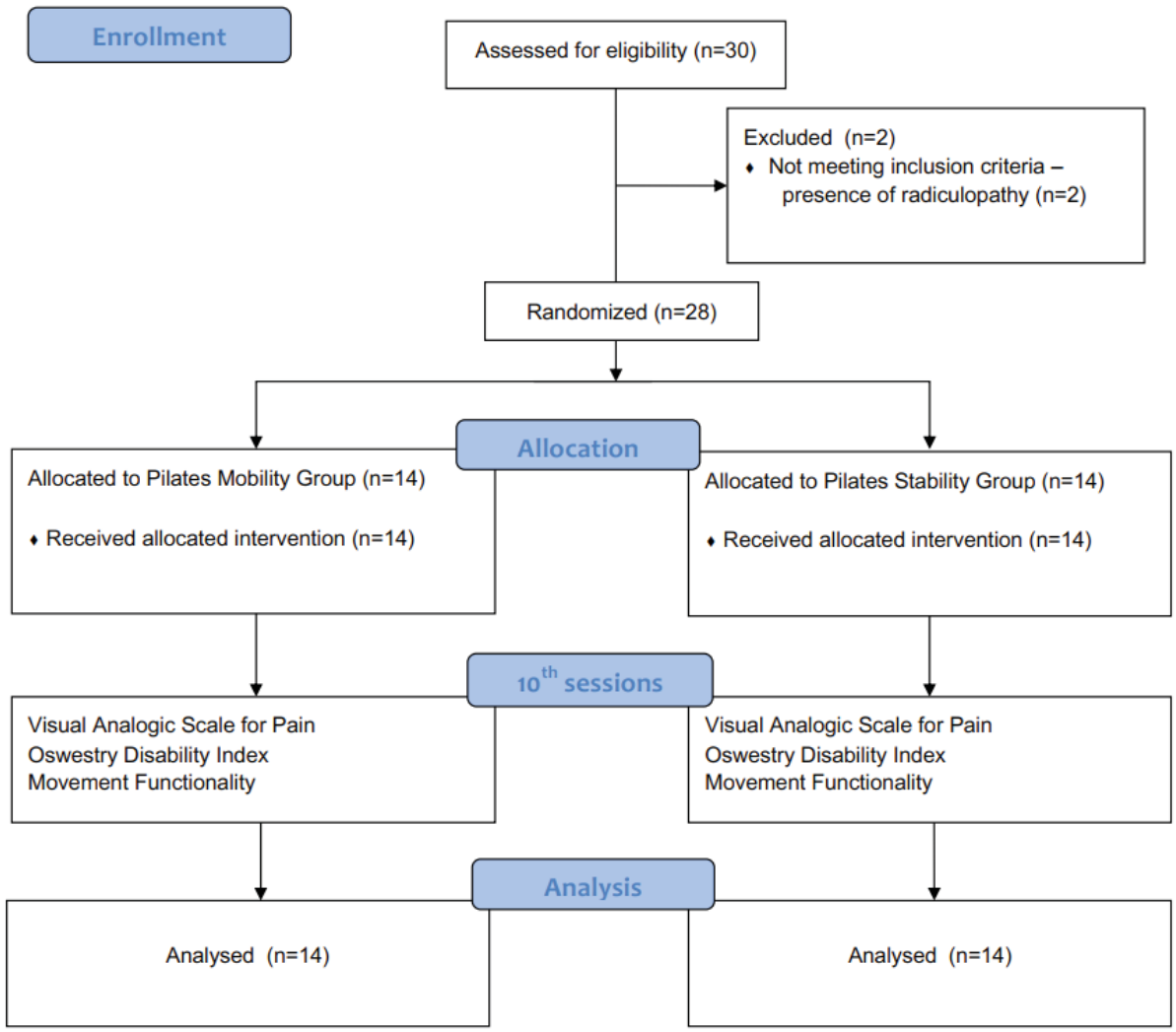

Figure 1: Participants flow diagram.

Table 2: Baseline demographic and clinical characteristics.

Baseline Characteristics	Pilates Mobility (n=14)	Pilates Stability (n=14)	Student T	p
Sex	6 F e 8 M	11 F e 3 M		
Weight(kg)	72.9(18.6)	72.4(13.9)	T(26 = -1.348	0.189
Height(m)	1.60(0.10)	1.67(0.9)	T(26)= 0.920	0.927
Age(years)	29.3(6.9)	32.5(5.7)	T(26)= 1.125	0.271
ODI	18.9(7.2)	20.9(6.0)	T(26)= -0.737	0.468
VAS	33.4(24.4)	40.4(25.8)	T(26)= -0.794	0.435
FMS	11(3.7)	11.2(2.6)	T(26)= -0.177	0.861

Table 3: Oswestry Disability Index results.

Factor	Outcome	Score(0-50) mean(Standard Error)	CI 95%	Anova F (DoF_{Factor}, DoF_{Error})	p	Effect Size(η^2)
GROUP	ODI	Mobility: 11.1(1.1)	8.9-13.4	F(1,26)= 2.551	0.122	0.089
		Stability: 13.6(1.1)	11.4-15.8			
TIME	ODI	Pre: 19.9(1.3)	17.3-22.4	F(1,26)= 119.611	<0.001	0.82
		Post: 4.9(0.7)	3.4-6.4			
TIME * GROUP	ODI	Mobility/pre: 18.9(1.8)	15.2-22.5	F(1,26)= 0.115	0.737	0.004
		Mobility/post: 3.4(1.0)	1.3-5.6			
		Stability/pre: 20.9(1.8)	17.2-24.5			
		Stability/post: 6.4(1.0)	4.2-8.5			

of biophysical, psychological and social associated factors [28-30].

Regardless the Pilates exercise program, both mobility and stability were effective to improve pain, disability and movement functionality in patients with chronic low back pain confirming our initial hypothesis. Following the concept that low back pain, most of the time, don't have a specific cause and is influenced by a broad range of factors [28], it is reasonable to think that the exercise by itself will improve pain and disability regardless the intention to focus on spine mobility or stability. The reason for the pain and disability improvement with exercise is due to central and peripheric endogenous opioid release and also by non-opioids mechanics such as the endocannabinoid system [31,32].

Very often clinicians prescribe exercise for chronic low back pain with a focus on biomechanics and musculoskeletal system(e.g. spine mobility and stability) [7,14]. However, although there are considerable physical changes in musculoskeletal system, current evidence suggest that these changes do not correlate with meaningful clinical outcomes [33].

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It is important to state that, in addition to our results presented a statistical improvement for pain, disability and movement functionality, those results were also clinically important [34,35]. It has been proposed that the minimal clinically important difference for Owestry Disability Index is around 6 points [36] and in our study disregarding the intervention group, the main factor time showed a disability improvement of 15 points (Table 3). In relationship to pain, disregarding the intervention group, the main factor time showed a pain improvement of 23.6mm and regardless the severity pain group, it is known that the minimal clinically important difference is around 10 to 15mm and our results (Table 4) were well above these values. Moreover, the movement functionality was also clinically important since our main factor time showed an improvement of 4.3 points after intervention and the minimal clinically important different is reported to be 1.25 points (Table 5). Therefore, pain, disability and movement functionality improvements were not only statistical, but also clinically important for individuals with chronic low back pain.

Those results of both exercise protocols being effective to improve pain and disability in chronic low back pain individuals are in accordance with literature, since there is no evidence to suggest that one form of exercise is better than another [4,37,38]. Therefore, both exercise programs are effective for improving low back pain outcomes and the recommendation fall within the individual needs, preferences, and capabilities of the individual.

There are a few important limitations for this study. The main limitation was related to the lack of follow-up in this study which is important to better understand the intervention outcomes, since people with history of back pain have a high incidence of new episodes of back pain. Unfortunately, due to limited time and resources with wasn't possible to perform a follow-up study. Pain is a difficult outcome to measure due to its multifaceted and subjective nature [28,39], and we only evaluated pain with a unidimensional scale and not using a multidimensional scale incorporating subjective pain tolerance or even a physiologic marker for pain like amount of sweetness, skin conductance or heart rate [39,40]. Other very important limitation was that we did not evaluated social and psychological factors which have a very important influence on low back pain and disability and it is know that Pilates can improve mental health outcomes [41].

Table 4: Visual Analogic Variable results.

Factor	Outcome	Millimeters(0-100 mm) Mean(Standard Error)	CI 95%	Anova F (DoF_{Factor}, DoF_{Error})	p	Effect Size(η^2)
Group	VAS	Mobility: 22.5(4.2)	13.9-31.2	F(1,26)= 0.763	0.390	0.29
		Stability: 22.7(4.2)	19.1-36.3			
Time	VAS	Pre: 36.9(4.8)	27.2-46.7	F(1,26)= 19.257	<0.001	0.43
		Post: 13.3(3.1)	7.0-19.6			
Time* Group	VAS	Mobility/pre: 33.4(6.7)	19.6-47.2	F(1,26)= 0.115	0.738	0.04
		Mobility/post: 11.6(4.4)	2.7-20.6			
		Stability/pre: 40.4(6.7)	26.6-54.2			
		Stability/post: 15.0(4.4)	6.1-23.9			

Table 5: Movement functionality outcome.

Factor	Outcome	Score(0-21 points) Mean(Standard Error)	CI 95%	Anova F (DoF_{Factor}, DoF_{Error})	p	Effect Size(η^2)
Group	FMS	Mobility: 13.7(0.7)	12.2-15.1	F(1,26)= 0.792	0.382	0.030
		Stability: 12.8(0.7)	11.3-14.2			
Time	FMS	Pre: 11.1(0.6)	9.9-12.4	F(1,26)= 50.395	<0.001	0.660
		Post: 15.4(0.6)	14.2-16.5			
TEMPO* GRUPO	FMS	Mobility/pre: 11.0(0.9)	9.2-12.8	F(1,26)= 3.420	0.076	0.116
		Mobility/post: 16.4(0.8)	14.7-18.0			
		Stability/pre: 11.2(0.9)	9.5-13.0			
		Stability/post: 14.4(0.8)	12.7-16.0			

Conclusion

Pilates exercise, regardless focusing on spine mobility or stability, can improve pain, disability and movement functionality in individuals with non-specific chronic low back pain. Besides, both Pilates exercises protocols had improved the outcomes, therefore the indication of one exercise protocol or other is based on the preference of the instructor or practitioner/patient.

Authors contributions

IFM participated in the design of the study, coordination, drafted the manuscript and will assess the outcomes. CS participated in the design of the study, reviewed the manuscript, coordination and will also randomize the intervention groups. ATS and LCC participated in the design of the study and will give the interventions to the participants. JFL participated in the design of the study and will perform the statistical analysis. All authors read and approved the final manuscript.

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