ORIGINAL RESEARCH

Predictive factors for progression through the difficulty levels of Pilates exercises in patients with low back pain: a secondary analysis of a randomized controlled trial

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Abstract
Background: The progression through the difficulty levels of Pilates exercises is a subjective criterion, that depends on the therapist's experience and ability to identify the best moment to progress to the next level.
Objective: To identify the factors that interfere in the progression through the difficulty levels of the Pilates exercises in patients with chronic nonspecific low back pain.
Methods: Data from 139 patients with chronic nonspecific low back pain from a randomized controlled trial were used for statistical analysis using binary logistic regression. The dependent variable was the progression through the difficulty levels, and the independent variables were age, gender, educational level, low back pain duration, pain intensity, general disability, kinesiophobia, previous physical activity, and number of absences.
Results: The factors that interfered in the progression through the difficulty levels were previous physical inactivity (odds ratio [OR] = 5.14, 95% confidence interval [CI]: 1.53–17.31), low educational level (OR = 2.62, 95% CI: 1.12–6.10), more advanced age (OR = 0.95, 95% CI: 0.92–0.98) and more absences (OR = 0.63, 95% CI: 0.50–0.79). These variables explain 41% of the non-progression through the difficulty level of the exercises.
Conclusion: Physical inactivity, low educational level, more advanced age and greater number of absences can be interfering factors in the progression through the difficulty levels of the Pilates exercises in patients with chronic nonspecific low back pain.

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Introduction

Chronic nonspecific low back pain corresponds to mechanical pain of musculoskeletal origin, not attributed to a recognizable back specific pathology, and lasting longer than 12 weeks.[1,2] The global prevalence of chronic low back pain is estimated at 31% and it is higher in women between the ages of 40 and 80.[3] In addition, chronic low back pain is one of the four most common diseases in all regions of the world as well as the main cause of years lived with disability in developed countries.[4] In Brazil, it was estimated that approximately 27 million people over the age of 18 (18.5%) reported a chronic back problem in 2013,[5] with a higher rate of women being affected.[5] Interestingly, the prevalence of chronic back problems was significantly higher among people with a low educational level than among those with a high educational level.[5]

Low educational level is one of the risk factors for the chronification of low back pain,[6] since education can be an important marker for some characteristics such as intelligence, acquisition of adaptive skills, or awareness of risk behaviors.[7] Other factors are also related to an increased risk for low back pain such as high levels of pain and disability, obesity, smoking, age, physical fitness, psychosocial factors (such as depression, pain catastrophizing, and fear of movement) and occupational factors (such as job dissatisfaction, high levels of exposure, and heavy lifting for extended periods), among others.[6,8–10] All of these factors should be taken into consideration in the treatment, because some factors could be associated with low back pain prognosis and exercise progression.

The clinical practice guidelines for the treatment of chronic nonspecific low back pain recommend supervised exercise therapy (exercises for motor control, trunk muscle strength and endurance, aerobic, mind–body or a combination of approaches), cognitive behavioral therapy, educational interventions, and manual therapy as part of a treatment package including exercise.[11,12] Exercise therapy is considered the first line of treatment[12,13] and an exercise modality that can be used for the treatment of patients is the Pilates method. There is current evidence that the Pilates method is superior to minimal intervention and similar to other forms of exercise in the treatment of patients with chronic nonspecific low back pain.[14]

Pilates method has six fundamental principles: concentration, centering, control, precision, flowing movement, and breathing.[15] In addition, exercises are structured in three difficulty levels, i.e., basic, intermediate, and advanced.[15–18] The basic level consists of exercises that are more stable and involve fewer muscle groups. The exercises become increasingly difficult as the patient progresses through the levels, requiring more strength and muscle groups to generate stability and greater balance and stretching.[19–21] In general, the progression through the difficulty levels is guided by the therapist, taking into account the patient's ability to perform eight to ten repetitions of the exercises without pain or postural compensations, following the principles of the method.[19–22] However, because it is a subjective criterion, the progression depends on the therapist's experience and ability to identify the best moment to progress to the next level. This may lead to patients being placed at a difficulty level above or below their actual ability, which can lead to pain and injury if the therapist rushes or to delayed progression if the therapist is too cautious. Therefore, the objective of this study was to verify the influence of demographic and physical factors that could delay progression through the difficulty levels of the Pilates method in patients with chronic nonspecific low back pain and to gather more objective information that therapist can use in clinical practice.

Methods

Study design

This is a secondary analysis of a randomized controlled trial[20,23] with prospective data collection that evaluated factors related to the progression through the difficulty levels of the Pilates method in patients with chronic low back pain. Data were collected from October 2013 to June 2014 in a randomized controlled trial, approved by the Research Ethics Committee of Universidade Cidade de São Paulo (UNICID), São Paulo, SP, Brazil (CAAE 18034113.7.0000.0064) and all the patients signed the informed consent, prospectively registered at the Clinical Trials Registry (NCT01919268) and funded by São Paulo Research Foundation (FAPESP process number 2013/17303-6), which had no influence on data collection or analysis. In this randomized controlled trial, 148 patients with chronic nonspecific low back pain were assessed by a blind assessor and treated with interferential current (active or placebo) and the Pilates method three times a week for a period of six weeks (18 sessions) at the Physical Therapy School Clinic of UNICID. The authors of this clinical trial concluded that the use of active interferential current prior to Pilates exercises was no more effective than placebo interferential current before the same exercises.[23] For the present study, the patients in the controlled trial were combined in a single group, as there was no difference between the groups for all primary and secondary outcomes. Of the original 148 patients, 9 did not attend any of the Pilates sessions and were excluded.

Participants

This study included 139 patients with chronic nonspecific low back pain of both genders, non-athletes, aged between 18 and 80 years, and pain equal to or greater than 3 points in the Pain Numerical Rating Scale.[24] Patients were excluded if they fit any of the following criteria: contraindications to physical exercise,[25] severe spinal diseases (fractures, tumors, infections, etc.) or nerve root compromise, sensitivity or allergy in the region of electrode positioning, skin lesions or infections at the site of interferential current application, cancer, cardiac pacemaker, pregnancy, previous spinal surgery, physical therapy for chronic low back pain in the last six months, and regular practice of Pilates. A specific sample calculation was not performed for this study. However, the guidelines for the number of participants required in a regression analysis were respected, i.e., a total number of 50 patients or more and a minimum number of 15–20 patients per variable.[26]

Data collection

The selected variables were: age, gender, educational level, previous physical activity, number of absences during treatment, low back pain duration, pain intensity evaluated by the Pain Numerical Rating Scale,[27] general disability assessed by the Roland Morris Disability Questionnaire,[27–29] and kinesiophobia evaluated by the Tampa Scale for Kinesiophobia.[30,31] These nine variables were chosen, based on the literature[7,32–34] and on the clinical experience of the researchers, since they were considered the ones most related to the progression through the difficulty levels of the Pilates method. Additionally, only nine variables were chosen because of the number of participants in the study, so that there would be 15 patients for each variable.[26] The two physical therapists responsible for the treatment had a specialization in traumatic orthopedic physical therapy with experience in the care of patients with chronic low back pain and five years of experience with the Pilates method. Physical therapists prescribed intermediate and advanced exercises when patients were able to perform 10 repetitions of the basic exercise easily, without pain and compensatory postures. The progression through the difficulty levels was collected in each session using a checklist with all of the exercises in which the physical therapist marked the difficulty levels of the exercises performed by the patients. The booklet with photos of the exercises has been previously published in the protocol of the randomized controlled trial.[20]

Questionnaires used to collect the clinical outcomes

Pain Numerical Rating Scale
This scale was used to assess pain intensity. It ranges from 0 to 10 points, with values closer to 10 indicating greater pain intensity.[27]

Roland Morris Disability Questionnaire
This questionnaire was used to evaluate disability related to low back pain. It consists of 24 dichotomous questions (yes or no), in which each yes answer is worth one point. The higher the score is, the greater the disability.[27–29]

Tampa Scale for Kinesiophobia
This scale was used to assess the patient's fear of movement. It is composed of 17 questions with answers worth 1–4 points. The total score varies from 17 to 68 points, and the higher the score is, the greater the degree of kinesiophobia.[30,31]

Statistical analysis

For the statistical analysis, the software program Statistical Package for Social Sciences (SPSS) version 15 for Windows was used. Initially, a univariate regression analysis was performed to determine the association between the independent variables of interest (age, gender, educational level, previous physical activity, number of absences during treatment, low back pain duration, pain intensity, disability and kinesiophobia) and the progression through the difficulty levels (dependent variable), the latter being presented as crude odds ratios (OR) and their respective 95% confidence intervals (CI). In addition, pseudo R^2 (Nagelkerke) values were presented as they provide a measure of the degree of adherence to the model (these values range from 0 to 1; the closer to 1, the better the adherence to the model).[35]

The progression through difficulty levels was dichotomized as follows: the patient who did not progress from basic to intermediate and/or advanced level during treatment was categorized as 0, while the patient who progressed from basic to intermediate and/or advanced level during treatment was categorized as 1. As Pilates exercises have three difficulty levels (basic, intermediate, and advanced), for each basic exercise, there was a similar one with the same therapeutic objective in the intermediate and advanced levels.[20] During the sessions, patients could perform exercises from the three difficulty levels. Thus, if the patient performed intermediate or advanced level exercises, he was considered to have progressed through the difficulty levels. In the analysis, when observing the progression data of all patients, we found that 35% of all exercises were performed at intermediate or advanced levels. This value was adopted as the goal, and all patients who performed 35% or more of intermediate and/or advanced exercises in each session were considered to have progressed through the difficulty levels.

The other independent variables were divided into categorical and continuous variables. The categorical variables analyzed were: (a) educational level, where the value of 0 was adopted for low educational level (primary or incomplete secondary education) and 1 for high educational level (complete secondary or tertiary education); (b) gender, where 0 was adopted for men and 1 for women; and (c) previous physical activity, where 0 was adopted for patients who were not physically active before treatment and 1 for patients who practiced regular physical activity at least twice a week before treatment, regardless of mode or frequency. The continuous variables were: (a) age, measured in years; (b) pain duration, measured in months; (c) number of absences during treatment, varying from 0 to 11 (12 Pilates sessions were offered); (d) pain intensity, ranging from 0 to

10 points; (e) disability, varying from 0 to 24 points; and (f) kinesiophobia, ranging from 17 to 68 points.

The variables with association values of $p \leq 0.20$ were included in the multivariate regression model. For the multivariate regression analysis, binary logistic regression was used. The forward method was used to enter each of the independent variables in this analysis. The final multivariate model considered the independent variables that presented $p < 0.05$ as factors associated with the progression through the difficulty levels of the Pilates exercises.

Results

Of the 139 patients with chronic nonspecific low back pain included in this study, the majority was married and physically inactive (82.7%). The number of female patients was 103 and their mean age was 44. Most patients had a low educational level (51.1%) and scored on average 6 points for pain intensity, 12 points for disability, and 41 points for kinesiophobia (Table 1).

All independent variables were included in the final model after the univariate analysis, except pain duration ($p = 0.76$) (Table 2). However, when analyzed in the multivariate model (Table 2), the independent variables capable

of predicting non-progression through the difficulty levels of the Pilates exercises were educational level, previous physical activity, age and number of absences ($p < 0.05$). Patients who were not physically active (OR = 5.14, 95% CI 1.53–17.31), with a low educational level (OR = 2.62, 95% CI 1.12–6.10), who were older (OR = 0.95, 95% CI 0.92–0.98) and who missed a greater number of sessions (OR = 0.63, 95% CI 0.50–0.79) were less likely to progress through the difficulty levels. Previous physical activity and educational level were the factors that most influenced the non-progression through the difficulty levels. Finally, the result of this model, composed of previous physical activity, educational level, age and number of absences was able to explain 41% of the factors related to non-progression through the difficulty levels of the exercises, as evidenced by the value of pseudo R^2 (Nagelkerke) = 0.41. The area under the ROC curve was 0.82, which showed the model ability to distinguish patients with the characteristics from patients who do not have the characteristics.

Discussion

This study aimed to verify the factors that could predict the progression through the difficulty levels of the Pilates method in patients with chronic nonspecific low back pain. Our results showed that lack of previous physical activity, low educational level, more advanced age and greater number of absences during treatment decrease the odds of progressing through the difficulty levels of the Pilates method in these patients. These variables explain 41% of the non-progression through the difficulty level of the exercises.

Previous physical activity is considered the most important predictor in the progression through the difficulty levels of the Pilates exercises. A possible explanation to this finding is that physically active patients find it easier to learn new exercises due to greater body awareness, motor control and muscular adaptation to new stimuli. Therefore, following the principle of neuronal neuroplasticity, changes in movement and behavior generate motor learning, thus improving motor capacity.[36] A fact that should be emphasized is that most of the assessed patients did not practice physical activity before treatment (82.7%), what makes sense, since pain can be a limiting factor of physical activity, leading to reduced movement in daily activities. This decrease in movement can be caused by physical problems (such as deficits in range of motion and muscle strength/endurance), fear of causing pain or worsening an ''injury'' (which in chronic pain involves more beliefs than a real possibility of injury) or instructions from health professionals reinforcing patients' negative beliefs.[36] Thus, health professionals should emphasize that the patient remains physically active, regardless of whether or not having treatment.[37] Finally, physical therapy treatment should be based on exercises with gradual progression starting from easier movements to more complex exercises, to further stimulate motor learning and positive cortical representation.

Although this is the first study to verify the factors that influence the progression through the difficulty levels of Pilates exercises, some studies[38–40] corroborate our findings by showing that a patient's educational level has a strong and positive association with physical activity. A higher

Table 1 Characteristics of participants at baseline ($n = 139$).

Characteristics	Baseline
Age (years)	44.3 (14.9)
Gender	
Female	103.0 (74.1)
Male	36.0 (25.9)
Weight (kg)	72.2 (15.6)
Height (m)	1.6 (0.1)
BMI (kg/m²)	26.5 (5.6)
Marital status	
Single	49.0 (35.3)
Married	67.0 (48.2)
Divorced	18.0 (12.9)
Widowed	5.0 (3.6)
Educational level	
Low	71.0 (51.1)
High	68.0 (48.9)
Previous physical activity	
Yes	24.0 (17.3)
No	115.0 (82.7)
Number of absences during treatment (0–11 absences)	1.4 (3.1)
Income (Brazilian Minimum Wage)[a]	4.7 (6.9)
Low back pain duration (months)	71.1 (78.6)
Pain intensity (0–10 points)	6.6 (1.7)
Disability (0–24 points)	12.3 (4.7)
Kinesiophobia (17–68 points)	41.4 (7.4)

Categorical variables are expressed in absolute and relative values (%) and continuous variables in mean and standard deviation.
[a] At the time of the study, the value of a Brazilian Minimum Wage was R$678.00/month.

Table 2 Predictive factors that influenced the progression through the difficulty levels of Pilates exercises.

Variables	Univariate regression		Multivariate regression		
	OR (95% CI)	p	Chi-square: 50.79[†]		OR (95% CI)
			B (SE)	p	
Educational level	2.86 (1.43–5.71)	0.00[*]	1.0 (0.4)	0.03[†]	2.62 (1.12–6.10)
Gender	2.32 (1.03–5.20)	0.04[*]	–	–	–
Pain duration	1.00 (1.00–1.01)	0.76	–	–	–
Age	0.97 (0.95–0.99)	0.01[*]	−0.1 (0.0)	0.00[†]	0.95 (0.92–0.98)
Pain intensity	0.80 (0.65–0.98)	0.03[*]	–	–	–
Disability	0.90 (0.84–0.98)	0.01[*]	–	–	–
Kinesiophobia	0.94 (0.89–0.98)	0.01[*]	–	–	–
Number of absences	0.69 (0.56–0.85)	0.00[*]	−0.5 (0.1)	0.00[†]	0.63 (0.50–0.79)
Previous physical activity	2.95 (1.09–7.96)	0.03[*]	1.6 (0.6)	0.01[†]	5.14 (1.53–17.31)

CI, confidence interval; SE, standard error; OR, odds ratio.
Univariate regression analysis: [*]statistically significant values ($p < 0.20$).
Multivariate regression analysis: [†]statistically significant values ($p < 0.05$).
Pseudo $R^2 = 0.41$ (Nagelkerke); Hosmer and Lemeshow = 5.5.

level of education provides knowledge and skills that are important for exercise practice, since it is related to intelligence and the acquisition of new abilities.[7] This is important in performing Pilates exercises, which require a moderate level of comprehension and concentration to be understood and well executed. In addition, the other fundamental principles of the method (such as breathing, powerhouse activation, precision, and control) must be followed so that the patient can execute the exercises without compensations and thus progress through the difficulty levels.[15,16] Therefore, patients should have a considerable level of intelligence and learning ability to correctly perform the principles and exercises of the method. Poor comprehension skills, combined in part with a low educational level, can influence the learning of principles and exercises, hindering the progression through the difficulty levels. However, educational levels are not related only to the progression of the exercises. A review[7] on the association between formal education and low back pain showed that people with a low educational level are also more likely to be affected by low back pain. Furthermore, back pain episodes appear to have longer duration and higher recurrence among patients with low education.[7]

An interesting finding of our study is that outcomes considered clinically relevant, such as pain duration, pain intensity, kinesiophobia and disability were not determinants in the progression through the difficulty levels of exercise. Patients with high levels of pain intensity, disability and kinesiophobia tend to progress in the same way as patients with low pain intensity, disability and kinesiophobia do. This finding is important so that pain cannot be a limiting factor in exercise progression in patients with chronic low back pain. The therapist should explain to the patient that, in these cases, pain is not related to injury but to central sensitization,[36,41] and should establish other limits to stop the exercises (such as a predetermined number of repetitions), which also helps to decrease beliefs that movement is harmful to the patient.[41]

The limitations of our study were the lack of data related to the adherence (or not) to all of the fundamental principles of the Pilates method by the patients and the level of body awareness that these patients had, since we believe that these factors can also influence the progression through the difficulty levels of the exercises. However, these are extremely difficult factors to measure. Other factors that may influence progression are the self-efficacy of these patients and what they think about the Pilates exercises in terms of difficulty and understanding. These qualitative data are difficult to include in a regression model. Regarding strengths, this was the first study to evaluate factors related to the progression through Pilates difficulty levels, which provides valuable information for clinicians on what to consider when treating their patients with this technique. In addition, it is a study that obtained its results prospectively from a randomized controlled trial with good methodological quality in a large sample representative of patients with chronic nonspecific low back pain treated with the Pilates method, which allows the generalization of the results for these patients. Thus, we suggest that future studies seek methods to collect variables such as adherence to the fundamental principles of the method and body awareness, as well as psychological factors (pain catastrophizing, depression and self-efficacy) and physical factors (balance, strength, and flexibility) to determine if these factors also influence the progression of the exercises. It is also important to evaluate whether the progression through the difficulty levels influences the improvement of pain intensity and disability in these patients.

Conclusion

The results of the present study show that low educational level, previous physical inactivity, more advanced age and greater number of absences during treatment are able to predict the non-progression of patients with chronic nonspecific low back pain through the difficulty levels of the Pilates method. In addition, factors such as pain intensity, disability, kinesiophobia, pain duration and gender do not influence this progression. These results show that Pilates

instructors should focus on explaining exercises in the most instructional way possible or even demonstrate the exercises to patients with a low educational level. It is also important to encourage them to adhere to the treatment when progressing through the difficulty levels of the Pilates method.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgments

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.bjpt.2018.04.004.

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