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Original Article

Effects of an acute resistance training session on pain and functional disability in people with chronic low back pain: a double blind controlled randomized trial

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Abstract
Introduction: People with chronic low back pain have functional disability associated with a decrease in productivity with major socioeconomic consequences. Resistance training is a form of exercise treatment that has been proposed to mitigate the problems caused by low back pain. It is recommended that the resistance training exercises focus on the posterior chain muscles and that the fragile condition of this population be considered. To the best of our knowledge, no study has yet investigated the effects of an acute resistance training session on pain and functional disability, considering such recommendations for people with non-specific chronic low back pain. Objective: Our aim was to assess the effects of a single resistance training session on pain and functional disability in people with non-specific chronic low back pain. Methods: 31 subjects of both genders with non-specific chronic low back pain took part in the study. Participants were randomized into two groups: the resistance training group (RTG) and the control group (CG). The RTG underwent a single exercise session. Results: The RTG showed a significant (p=0.001) decrease in perceived pain (5.9±1.6 versus 4.9±1.8) and a significant (p=0.016) decrease in functional disability (25.6±6.3 versus 20.5±4.1), after the resistance training session. The CG did not show significant differences (p=0.190) in perceived pain (6.9±1.7 versus 7.4±1.9)and in functional disability (26.8±7.8 versus 27.8 ±9.2), after the final assessment. The RTG showed a significant (p=0.001) increase in strength between the initial and final assessments (47.7 ±26.6kgf versus 60.2 ±31.4kgf) while the CG did not show any differences. Conclusion: A single resistance training session reduces pain and functional disability in people with chronic non-specific low back pain.
Key words: chronic low back pain, resistance training, functional disability, pain

Introduction

Low back pain is defined as the presence of pain between the lower margins of the 12th pair of ribs and the inferior gluteal fold; than can be followed by pain in one or both legs (Hartvigsen et al., 2018). Low back pain lasting more than 12 weeks is classified as chronic injury (Qaseem et al., 2017). Non-specific chronic low back pain (NSCLBP) affects people of both genders between 20 and 59 years of age, being attributed to a mechanical cause of unknown musculoskeletal origin. In addition to the lumbar region, pain may be present in the buttocks and thighs, although it does not have a radicular cause (Waddell Gordon, 2004).

NSCLBP causes functional disability in people, that is frequently associated with a decrease in productivity and absence from work (Buchbinder et al., 2018), with important socioeconomic consequences (Buchbinder et al., 2018; Foster et al., 2018; Hartvigsen et al., 2018). Therefore, over the last few years, various forms of exercise treatments have been proposed to mitigate the problems caused by NSCLBP (Owen et al., 2019; Searle et al., 2015), being resistance training (RT) one of those (Kristensen & Franklyn-Miller, 2012). However, the scarce number of studies in the subjects questions its effectiveness. For example, it was seen that even after sixteen weeks of strength training, the participants still experienced pain and moderate functional disability (Kell et al., 2011; Kell & Asmundson, 2009).

The RT has its own exercise prescription guidelines (Adams et al., 2009). Nevertheless, only two studies have offered RT, considering those guidelines, to participants with NSCLBP (Kell et al., 2011; Kell & Asmundson, 2009). However, these two studies failed to effectively solve the functional disability and pain issues. Probably, because they did not use the recommendations of resistance training for fragile people (Garber & Blissmer, 2011), and because they did not use the most responsive exercises for this population (Tataryn et al., 2021). Taking this into account, we proposed a RT protocol emphasizing on the posterior chain muscles and on the abdominal muscles. We offered an acute RT session with at low intensity, following the recommendations for fragile people (Garber & Blissmer, 2011). Thus, the aim of the present study was to assess the effects of a single RT session on pain and functional disability in people with NSCLBP. Our hypothesis is that a single RT session, prescribed according to the frailty condition presented by this population, is able to reduce functional disability and pain in people with NSCLBP.

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Material & methods

Experimental design

This is a double-blind, randomized, experimental study, characterized as a clinical trial. Our purpose was to assess the effects of an acute session of RT on pain and functional disability in people with NSCLBP. The study was carried out within the ethical standards of the Declaration of Helsinki and in accordance with Resolution 196/96 of the Ministry of Health. The present study was approved by the ethics committee for research involving human beings (CAAE: 51078721.5.0000.5500) and by the Brazilian registry of clinical trials (UTN: U1111-1273-0751).

The participants were sampled through radio and television network advertising as well as online media advertising . Interested candidates answered an online questionnaire to check if they met the inclusion criteria. The inclusion criteria were as follows: presenting low back pain for more than 3 months, with at least two episodes a week; not having a diagnosis of disc herniation confirmed by magnetic resonance imaging; aged between 20 and 59 years; having a functional disability score between 21 and 60 in the Oswestry questionnaire; having a body mass index of no more than 30; not being engaged in any physical exercise program for 3 months; and agree not to use analgesic medication during the study. After this initial screening, the participants were evaluated by a physiotherapist and the ones with a herniated disc, severe spinal pathology and/or any radicular problem were excluded (Figure 1).

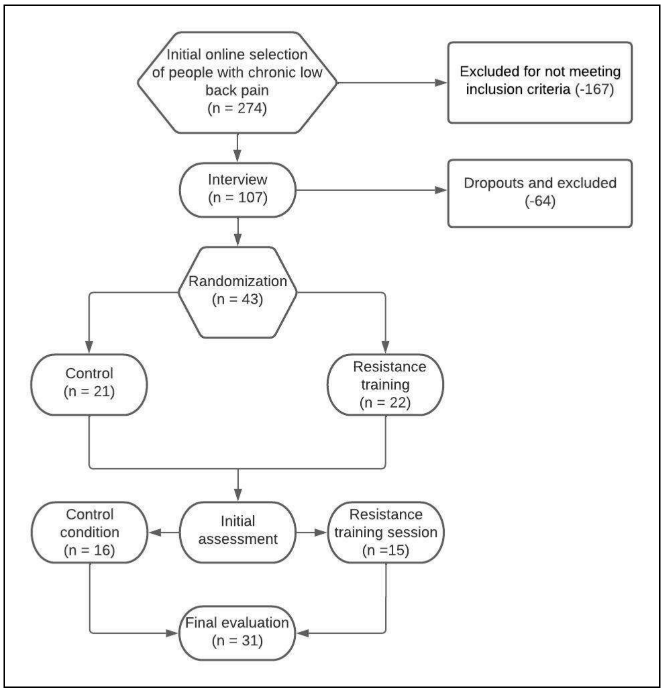

Figure 1. Illustrative flowchart of the experimental design

Participants

The study included 31 participants of both sexes: 15 resistance training group (RTG) (4 men and 11 women) participants and 16 subjects control group (CG) (3 men and 13 women) participants.

Procedures

In the initial assessment, all participants answered the pain and functional disability questionnaires. In the low back pain questionnaire, the participants were asked to register their pain perception in the week before. In the functional disability questionnaire, the participants followed the questionnaire guidelines to answer each question. After that, all participants performed a multi-joint maximal voluntary contraction strength test. One submaximal contraction of 10 seconds was performed for warm-up, followed by three maximal contractions of 5 seconds, with 1 minute interval. The highest value obtained from the three attempts was registered. After that, the RTG participants performed the resistance training session.

One week after the initial assessment and the resistance training session, all participants returned to the Laboratory and answered the pain and functional disability questionnaires and were reassessed in the multi-joint maximal voluntary contraction strength test.

Resistance training session

The resistance training session performed by the RTG consisted of the following exercises: hex bar deadlift, Roman chair exercise and crunches (Figure 2). Three sets of ten repetitions were performed for each exercise, with 1 minute rest between sets. At the end of each set, the participants answered the resistance exercise scale of perception exertion (OMNI-RES)

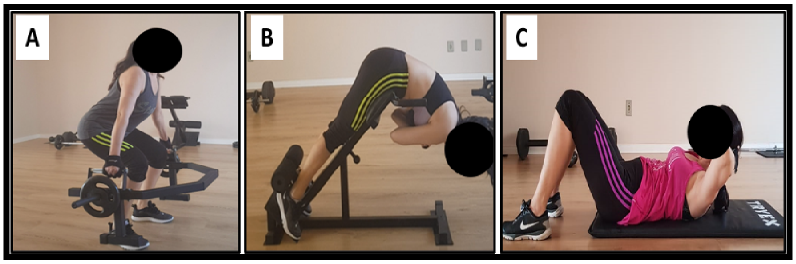

Figure 2. Exercises performed in the acute resistance training session: A) Hex bar deadlift, B) Roman chair exercise C) Crunches

The hex bar deadlift was performed with 30% of the maximum voluntary contraction obtained in the multi-joint test (MVC), developed for this study. The participants were instructed begin the movement holding the bar with the knees and hips extended. Then, they should flex the knees until the bar reached the height of the knees and then returned to the initial position. The mean knee and hip flexion of all participants was 92.2º ±9.8º and 82.4º ±9.2º, respectively. The joint center of the knees exceeded the tip of the toes by 0.04m ±0.03m. For the participants who found difficult to keep their heels on the ground during knee flexion, a wedge was used under the heels. The subjective perception of exertion in this exercise was 4.6 ± 1.4 in the OMNI-RES scale.

The roman chair exercise was performed on a roman bench inclined at 45º. The exercise was performed without adding extra load. The participants' anterosuperior iliac spines were in contact with the bench, which allowed fixating the pelvis preventing hip movement. The participants were asked to initiate the movement in the upright position on the bench. Then, they were instructed to flex their trunk as much as possible. Finally, after reaching the maximal trunk flexion, they should extend their trunk back in the upright position, without hyperextending the spine. The mean amplitude of trunk movement was 36.9º ±10.0º. The subjective perception of exertion in this exercise was 5.4 ± 2.1 in the OMNI-RES scale.

The crunches were performed on a mat on the ground with the subjects lying supine, with knees flexed and hands resting behind the head. From this position, the participants' were instructed to flex the lumbar spine as much as possible. The subjective perception of exertion in this exercise was 3.8 ±1.5 in the OMNI-RES scale.

Instruments

Low back pain intensity was measured using an 11-point numerical scale. This scale was numbered from 0 to 10, where 0 means no pain, and 10 means the worst pain imaginable. (Ferreira-Valente et al., 2011)

Functional disability was measured using the Oswestry disability questionnaire. This questionnaire consists of 10 questions with six alternatives. A score between 0 to 5 must be answered in each question. Then, the sum of all answers is converted in a percentage, that expresses the inability to perform daily tasks and activities (Vigatto et al., 2007). The subjective perception of exertion in the resistance training session was assessed using the OMNI-RES scale (Lagally & Robertson, 2006).

The range of motion of the hex bar deadlift and the roman chair exercise was measured by two-dimensional kinematic analysis using a digital camera sampled at 90 fps (Web Logitech BRIO). Raw data wase processed using myovideo software (Noraxon®). Kinematic markers were placed on the acromion, posterior superior iliac spine, anterior superior iliac spine, iliac crest, greater trochanter of the femur, knee joint center, lateral malleolus, and on the distal phalanx of the hallux. All markers were positioned on the right side of the participants's body.

The MVC was assessed with a calibrated and certified by Inmetro (National Institute of Metrology, Quality and Technology) load cell (Kratos®) built in a device (Figure 3). A digital display allowed to record the maximum force produced by the participant during an isometric contraction. The test showed an intraclass correlation coefficient (ICC) of 0.72.

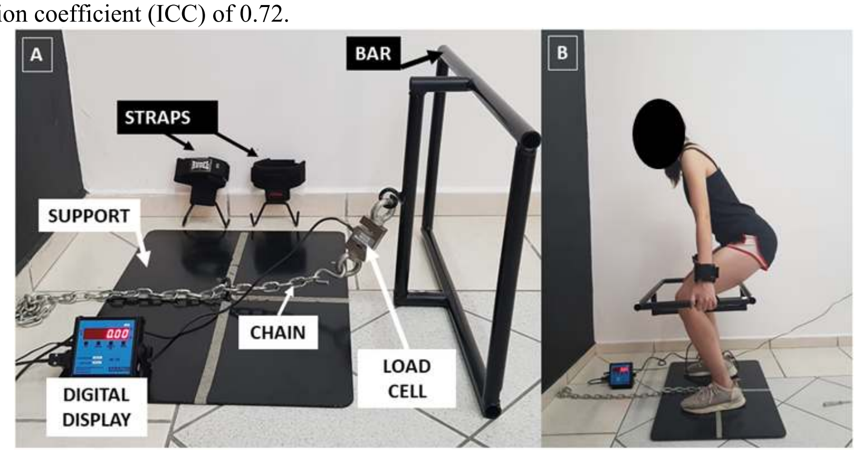

Figure 3. Device built with a load cell to evaluate maximal voluntary contraction. A: Load cell device; B: Test position

Statistical analysis

Data normality was verified by Kolmogorov-Smirnov and Mauchly tests respectively. Comparison of pain perception and functional disability between groups at two different assessment moment were performed using a two-way analysis of variance for repeated measures. Then, group (experimental and control) and time (before and after) were the two factors. When necessary, the post-hoc SNK was used. The significance level adopted was 5% and all analyzes were performed using SigmaStat 3.5 software. Comparison of maximum strength was performed separately using the same statistical model.

Results

The differences between the RTG and the CG, in the initial moment, are presented in the table below (Table 1).

Table 1. Mean ($\bar{x}$), standard deviation (σ), T test value (t) and p-value (p) for the resistance training group (RTG) and control group (CG), showing the differences at the initial moment in age, mass, height, body mass index (BMI), total time of low back pain, total number of days of the week with pain, Oswestry functional disability and numeric pain scale (n = 31).

Variables	RTG		CG		t	p
	$\bar{x}$	σ	$\bar{x}$	σ		
Age, years old	43.7	9.8	39.3	8.8	1.32	0.190
Mass, Kg	74.2	7.6	67.3	13.1	-1.79	0.080
Height, m	1.65	0.06	1.65	0.09	-0.03	0.970
IMC, Kg/m^2	27.1	2	24.5	3	-2.76	0.009
Time in pain, years	6.9	6	5.6	3	-0.78	0.440
Days in pain, weeks	5.5	1	4.9	1	-1.43	0.161
Disability, %	25.6	6.3	26.8	7.8	0.49	0.622
Pain scale	5.9	1.6	6.9	1.7	1.68	0.102
Maximum strength, kgf	47.7	26.6	46.6	21.7	-0.11	0.905

Pain perception and functional disability results showed interaction between group and time factors ($p<0.016$). The RTG showed a significant reduction in pain perception (5.9±1.6 versus 4.9±1.8), between the initial and the final assessments($p=0.001$). Functional disability also showed a significant reduction for this group (25.6±6.3 versus 20.5±4.1) ($p=0.016$). The control group did not show a significant difference for pain (6.9±1.7 versus 7.4±1.9), , nor for functional disability (26.8±7.8 versus 27.8 ±9.2). The differences between the groups are presented in figure 4.

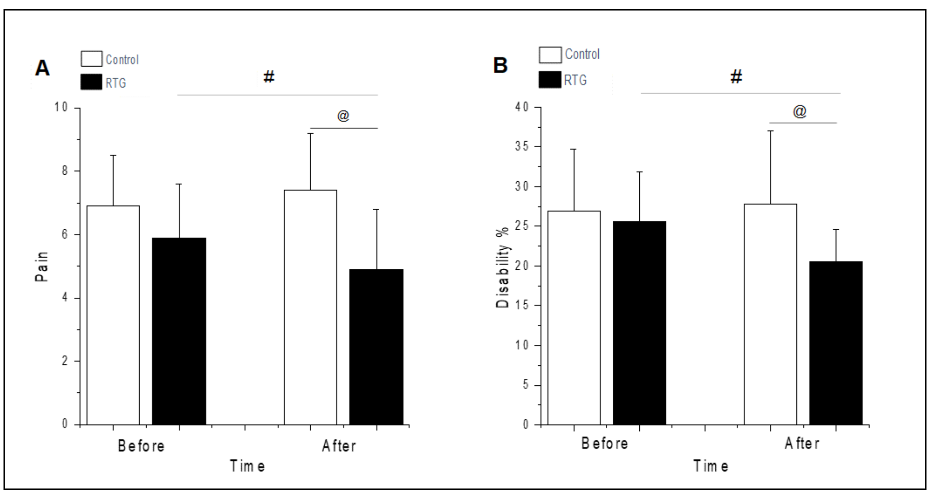

Figure 4. A) Subjective perception of pain. B) Functional disability. @Significantly lower value for the resistance training group (RTG) compared to the control group at the “After” time ($P<0.016$); #Significantly lower value at the “After” time compared to the “Before” time for the RTG ($P<0.016$). There was a significant interaction between group and time factors ($P<0.016$).

The results of the multi-joint maximal voluntary contraction force showed interaction between the group and time factors ($p=0.001$) and it was not different between the RTG versus CG in the initial assessment (Table 1), nor in the final assessment (60.2 ±31.4kgf versus 48.9 ±25.1kgf). The CG did not show significant differences in the multi-joint maximum voluntary contraction force between the initial and final evaluations (46.6 ±21.7kgf versus 48.9 ±25.1kgf). However, the RTG presented a significantly ($p=0.001$) higher force value in the final assessment when compared to the initial on (47.7 ±26.6kgf versus 60.2 ±31.4kgf).

Discussion

Corroborating our hypothesis, the present study found a reduction in pain and functional disability in subjects with non-specific chronic low back pain after a single session of resistance training exercises. To the best of our knowledge, this is the first study to apply a single strength training session to assess the effectiveness of the training program in this population. Thus, the proposed protocol exercise seems to be a promising strategy for people with non-specific chronic low back pain. Berglund et al., (2017) used a strength training protocol of 16 sessions with the deadlift exercise, which consisted of 5 maximum repetitions (5RM). Nevertheless, that protocol did not promote pain reduction. A possible explanation might be due to the high intensity exercise performed by the participants with CLBP. In our study, a single resistance training session, showed a 16.9% reduction in pain perceived. We believe the low intensity exercise (30% of the MVC and 4.6 ±1.4 of the OMNI scale) used in the deadlift favors the pain reduction for people with non-specific chronic low back pain.

Some studies in the literature have used a specific machine to test the isometric strength of the trunk and hip extensors to prescribe the intensity of a specific exercise for people with non-specific chronic low back pain (HELMHOUT et al., 2004; STEELE et al., 2016; STEELE; BRUCE-LOW; SMITH, 2013). In our study, the intensity of the hex bar exercise was based on the isometric MVC test, performed in a very specific equipment, developed by us (Figure 3). Such equipment seems to be a practical solution to prescribe the initial intensity of the hex bar exercise for people who are fragile and/or affected by low back pain. This seems to be plausible since using 30% of the MVC in the deadlift exercise, the participants reported a perception of exertion that ranged between somewhat easy and somewhat difficult (4.6±1.4) in the OMNI-RES scale (ROBERTSON et al., 2003). Since our resistance training session reduced the participants' pain and functional disability, we believe the protocol intensity is suitable for people with chronic low back pain. Steele et al., (2013) assessed the effects of a 12-week exercise protocol in a lumbar extension machine (Medx), at 80% of the maximum torque. At the end of the protocol, the participants did not reduced the level of functional disability. The exercise protocol proposed in this study seems to be promising for longitudinal studies. We believe that if with a single exercise session the subjects showed a reduction in functional disability (25.6±6.3 to 20.5±4.1), this protocol applied chronically should promote further beneficial effects. We assessed the participants' maximal multi-joint voluntary contraction strength in both time points. We found no significant difference in the maximal strength between the CG and the RTG in the initial nor in the final assessment. Since a single resistance training session was able to increase the strength in this test, one may speculate that a longitudinal study with this protocol may lead to further increases in strength. We believe this almost instantaneous increase in strength level is due to pain decrease these participants reported at the final assessment. Acute pain is usually caused by an injury to the body`s tissue that leads to the nociceptive transducers activation in the damage tissue. This injury alters the response characteristics of the nociceptors and the autonomic nervous system in the tissue region. This type of pain usually lasts for a few days or a few weeks, and treatment with non-steroidal anti-inflammatory drugs (NSAIDs) may relief pain (Loeser & Melzack, 1999). However, the participants of the present study had chronic low back pain. The treatment of a chronic pain differs from the treatment of an acute pain. That is, treatment with NSAIDs has little effect on reducing pain. One possible explanation is that people with non-specific chronic low back pain had experienced failure in previous treatments which augmented several stress factors that were superimposed on the original damaged tissue, contributing to the persistence of pain (Waddell Gordon, 2004). The scientific community suggest that long-term intervention with resistance training is a suitable strategy in promoting pain relief in people with CLBP (Kristensen & Franklyn-Miller, 2012). Our contribution seems to be the first to show a significant reduction in pain with just a single resistance training session. Pain is an unpleasant sensory and emotional experience, which can lead to adverse effects on people's physical function (Aydede, 2019). The pain decrease with a concomitant reduction in functional disability found in the present study seems to corroborate the notion that pain and physical function are undissociated factors (Waddell Gordon, 2004).

Conclusion

An acute resistance training session comprising three exercises targeting the posterior chain muscles and the abdominal muscles, performed at low intensity (30% of the MVC), was able to reduce pain and functional disability in people with non-specific chronic low back pain. This pioneering study paves the way to a novel approach in treating this injury.

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