

Lumbar stabilisation exercises versus back endurance-resistance exercise training in athletes with chronic low back pain: protocol of a randomised controlled trial

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ABSTRACT

Background Chronic low back pain (CLBP) is an important disorder in athletes that may negatively affect their performance in competitions. The literature usually recommends physiotherapy based on exercises for back pain management in athletes. Recent evidence suggests that interventions based on lumbar muscle stabilisation exercises (LMSE) and back endurance-resistance exercises (BERE) may improve back pain and function performance. However, it is still unclear which type of exercise is more effective for the treatment of CLBP in athletes.

Objective To compare the efficacy of LMSE versus BERE in athletes with CLBP.

Design The study is a 2-arm, prospectively registered, randomised controlled trial.

Setting The physical therapy clinical and biomechanics laboratory of the UNOPAR University.

Participants 32 male athletes with CLBP, age between 18 and 40 years old, recruited from the local community.

Intervention An 8-week intervention programme will be carried out with LMSE s versus BERE.

Measurements Trunk neuromuscular patterns during balance tasks (unipodal and over a ball) using electromyography and force platform parameters, pain, disability, fear and avoidance will be assessed by a blinded assessor at baseline and at follow-up after 8 weeks of intervention period.

Limitations The absence of blinding intervention and the exclusion of female athletes, seated sports and swimmers will affect the internal and external validity of the study.

Conclusions The results of this study will elucidate which of these two interventions promote better results in trunk neuromuscular pattern, back pain and function in male athletes with CLBP.

INTRODUCTION

Chronic low back pain (CLBP) is a major cause of disability worldwide and affects 85% of the general population.¹ CLBP has been

reported in 17% of all patients diagnosed with any musculoskeletal condition.² In the sports environment, the scenario is not different. Even in amateur athletes, the prevalence can reach 27%, while in professional athletes, the proportion doubles, reaching 61%.¹ CLBP has a 30% incidence in sports and accounts for 10%–15% of sports injuries with 0.36–0.49 lumbar injuries for every 1000 athletes.^{3,4} In 90% of cases, CLBP is reported as having a non-specific origin, without a specific source of pain related to a herniated disc, systemic disease (rheumatological), infection, fracture or tumour.^{1,3}

Poor back muscle endurance has been shown to be a predictor of a first episode of low back pain as well as long-term back-related disabilities and CLBP.⁵ The excessive fatigue of back muscles in subjects with CLBP may be associated with a shift in muscle fibre proportion towards type II fibres and reciprocal atrophy of the lumbar muscles (multifidus, iliocostalis).⁶ Trunk muscle fatigue may increase neuromuscular deficits, resulting in brief uncontrolled movements from the lumbar spine and then subsequent tissue strain injury and low back pain.⁷

Lumbar spine stability is maintained by various motor strategies, which modulate the pattern of muscle recruitment in relation to mechanical demands.⁸ In daily activities, the deep muscles of the trunk represented by the transverse abdomen, multifidus and internal oblique are primarily activated as compared with muscles that move the lower and upper limbs and the other muscles that move the trunk itself.⁸ This set of stabilising muscles exhibits a coordinated pattern of activation, which aims to increase the stability, creating



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a stable central pillar around the lumbar spine.⁸ This mechanism limits vertebral intrasegmental mobility and facilitates follow-up movements of the peripheral body.⁸

In the concept of lumbar stability proposed by Panjabi, fatigue of the trunk muscles increases the risks of neuromuscular deficits, causing uncoordinated movements (ie, poor motor coordination),⁹ increasing the instability of the spine and thus contributing to overload and injury in passive structures such as ligaments and joints. The final effect of this cascade of events is pain.⁹

In individuals with CLBP, lumbar muscle fatigue, abdominal and paravertebral weakness, poor motor coordination, imbalance and proprioception can be considered as probable sources of pain.¹⁰ However, in athletes, these mechanisms are not fully elucidated.⁷ Guidelines and systematic reviews in rehabilitation recommend active interventions such as LMSE and back endurance-resistance exercises (BERE) for the general population with CLBP based on strong evidence.^{11 12} LMSE and BERE interventions for the treatment of CLBP are well established in the general population, but not in athletes.¹³ Athletes in training and competitions perform high physical exertion when compared to the activities of daily living, they have a better physical condition than the general population and yet suffer from low back pain.¹³

OBJECTIVE

This study is intended to determine whether there are superior effects of one intervention programme over another when comparing lumbar muscle stabilisation exercises (LMSE) versus BERE for trunk neuromuscular patterns (during fatigue and balance tasks), trunk strength, pain, disability and psychosomatic variables in athletes with CLBP. The hypothesis is that both intervention programmes will reduce pain, disability and psychosomatic symptoms (fear and avoidance), while for balance variables, the LMSE would promote better results. Between the two types of proposal exercises, it is likely that the stabilisation exercises will show better outcomes, because they are global exercises against local exercises performed in endurance-resistance exercises. Contrarily, for fatigue variables, the BERE training would improve further when compared with the LMSE in clinical meaningful differences and effect size (ES).

METHOD

Study design

This study will consist of a 2-arm, prospectively registered randomised controlled trial.

Study setting

The study setting will be UNOPAR University, at the Physical Therapy Clinic, in the Laboratory of functional evaluation and human motor performance (LAFUP), Londrina PR, Brazil.

Eligibility

Male athletes with a minimum age between 18 and 40 years old will be recruited.

Inclusion criteria

Athletes with non-specific CLBP (defined as LBP for more than 12 weeks without a precise clinical diagnostic). Athletes had to participate in level-I (jumping, pivoting, hard cutting like basketball, handball, soccer) or level-II sports (less jumping or hard cutting than level I, like volleyball, racket sports, martial arts, gymnastics) and training or playing five times per week.¹⁴ Athletes must be participating in some official competitions (estate, national or international competition).

Exclusion criteria

Individuals with previous musculoskeletal surgery, disc herniation diagnosis, nerve root entrapment, spondylolysis, spondylolisthesis, lumbar stenosis, hip cartilage damage or labral injury, piriformis syndrome, neurological disease as well as athletes who participated in current physical therapy, pilates or manual therapy treatment were excluded. Athletes who are using analgesics, dietary supplementation and/or anabolic steroids will also be excluded.

Procedure

Two investigators (trained physiotherapists) will collect the demographic data (name, date of birth and gender), basic anthropometric measurements (weight, height, body mass index), history of CLBP and clinical symptoms (factors that alleviate or aggravate symptoms) prior to randomisation. Before randomisation, participants will be matched for the maximal voluntary isometric contraction (MVIC) of back muscles, measured by electromyography (EMG). Eligible participants will be blinded and randomised in equal proportions between the two groups: Group-1 (G1, n=16) LMSE and Group-2 (G2, n=16) BERE. The participants of the two groups will participate in an 8-week intervention programme of treatment for two non-consecutive days each week. The two groups will be monitored by experienced physiotherapists (>5 years of experience) who will supervise the exercise programmes, placing each patient into the appropriate position to achieve the correct posture and muscle contraction. Each treatment session will be 50 min long, including 10 min warm-up stretching exercises and 10 min cooling down after each session for all the athletes in both groups. For adherence, a short individual class orientation after the day's treatment will be done, where the physiotherapist gives a brief explanation on the importance of continued participation in the proposed treatment.

Outcomes

The assessments will be as follows: (1) pain intensity and behaviour, (2) disability, (3) fear and avoidance, (4) trunk neuromuscular activation, (5) back muscle fatigue

(6) back strength and (7) running shuttle functional performance.

Questionnaires

Four clinical and pain-related psychological variables will be assessed in all athletes with CLBP: (1) pain intensity perceived by the patient on the day of testing with a visual analogue scale (VAS),¹⁵ (2) pain quality with the Short version of McGill Pain Questionnaire,¹⁶ (3) perception of disability with the Oswestry Disability Index,¹⁷ (4) beliefs about how physical activity would affect CLBP with the Fear-Avoidance Beliefs Questionnaire.¹⁸

Instrumentation

A trained professional who will be blinded to the evaluation measures conducted the procedure for all participants to eliminate intertester measurement error.

Before starting the instrumentation, all individuals will be given 3 min for familiarisation, 1 min sitting on a Swiss ball, 1 min on a Roman Chair and 1 min on the force platform.

Surface electromyography (EMG)

EMG signals will be collected from six preamplified (gain: 1000) active surface electrodes (Model DE-2.3; Delsys, Wellesley, Massachusetts, USA) at a sampling rate of 2000 Hz with a Bagnoli-8 EMG System (Delsys). All EMG signals will be subsequently bandpass filtered (20 and 450 Hz; eighth order zero-lag Butterworth IIR filter) to remove high frequency noise as well as low frequency movement and ECG artefacts. In fact, the ECG is dominant in torso EMG signals, which mandates the use of a high-pass cut-off frequency.¹⁹ After the skin at the electrode sites is shaved and swabbed with alcohol, the electrodes will be positioned bilaterally on the multifidus at the L5 level (MU-L5-Left and MU-L5-Right) and on the iliocostalis lumborum at the L3 level (IL-L3-L and IL-L3-R), with regard to muscle fibre direction.¹⁹ To secure the placement of electrodes for the preintervention and postintervention assessments, a template was produced during the baseline measure (pre-session) by copying electrode locations as well as natural skin blemishes on an acetate.

Two additional electrodes will be positioned over both gluteus medius (GM), placed at 50% on the line from the iliac crest to the major trochanter. For GM activation, the MVIC will be computed by root mean square (in microvolts unit: μV). The individual will remain in lateral decubitus and will perform an abduction with the inferior limb placed above. The MVIC will be done three times, with 5 s of contraction and 1 min of relaxation. The maximum value will be computed. All participants will be encouraged by verbal feedback.²⁰ A reference (ground) silver-silver chloride electrode will be positioned over the T8 spinous process.¹⁹

Force platform

A BIOMECH 400, EMG System, SP, Brazil will be used. The vertical ground reaction force data from the force platform is adjusted at 100 Hz to perform the task. All force signals are filtered with a 35 Hz low-pass second-order Butterworth filter and converted into centre of pressure (COP) data using MATLAB-based routines (Mathworks, Natick, Massachusetts, USA). COP data will be used for calculations:^{21 22} (1) 95% confidence elliptical area of COP (A-COP in cm^2), (2) mean velocity (VEL in cm/s) and (3) mean frequency (in Hz) of COP sway for both anteroposterior (A/P) and mediolateral (M/L). The reliability of COP parameters has been supported in the literature for young adults both with and without CLBP (based on the intraclass coefficient correlation: $\text{ICC} > 0.80$ and $\text{SEM} < 1.30$).²³ These parameters will be calculated for the total duration of each trial and the mean of three trials analysed.²⁴

Figure 1 depicts the study flowchart.

Sample power calculation

We used the best data available at this time to estimate the sample size, because no study has investigated these effects on back endurance outcome. These data were from a study that shows what effects back stabilisation and endurance exercises training have on back maximal strength measure comparable to what was used in the present study (using a similar principle back effort test), namely, MVIC (details in the succeeding paragraphs).¹³ Pre-post results were considered as independent (from two groups) to comply with the present statistical analyses (between-group factor). From the mean clinical differences after intervention across 0° – 12° of trunk flexion during back effort test, the values were 26.5 ft-lb for endurance group versus 46.5 ft-lb for stabilisation group (with similar $\text{SD} = 20$ ft-lb).¹³ A statistical power table corresponding to t-tests (bilateral testing), an ES of 1.00 (slightly more conservative) and a power of 0.80 were used to determine that each group required 16 participants.

Recruitment

Volunteers will be recruited from the local community and sports centres of Londrina city and surrounding regions. Athlete recruitment will be done using fliers, local papers, radio and television. Fliers will be sent to sports centers, sports club and local newspapers. All athletes will be informed about the research procedure and a consent form will be read and signed before any study procedures.

Random allocation

After being matched (double) by the MVIC, participants will be randomised into two groups (G1: LMSE and G2: BERE) by a blinded evaluator using computer-generated randomisation.

Blinding

Only the assessor will be blinded to treatment group assignment.

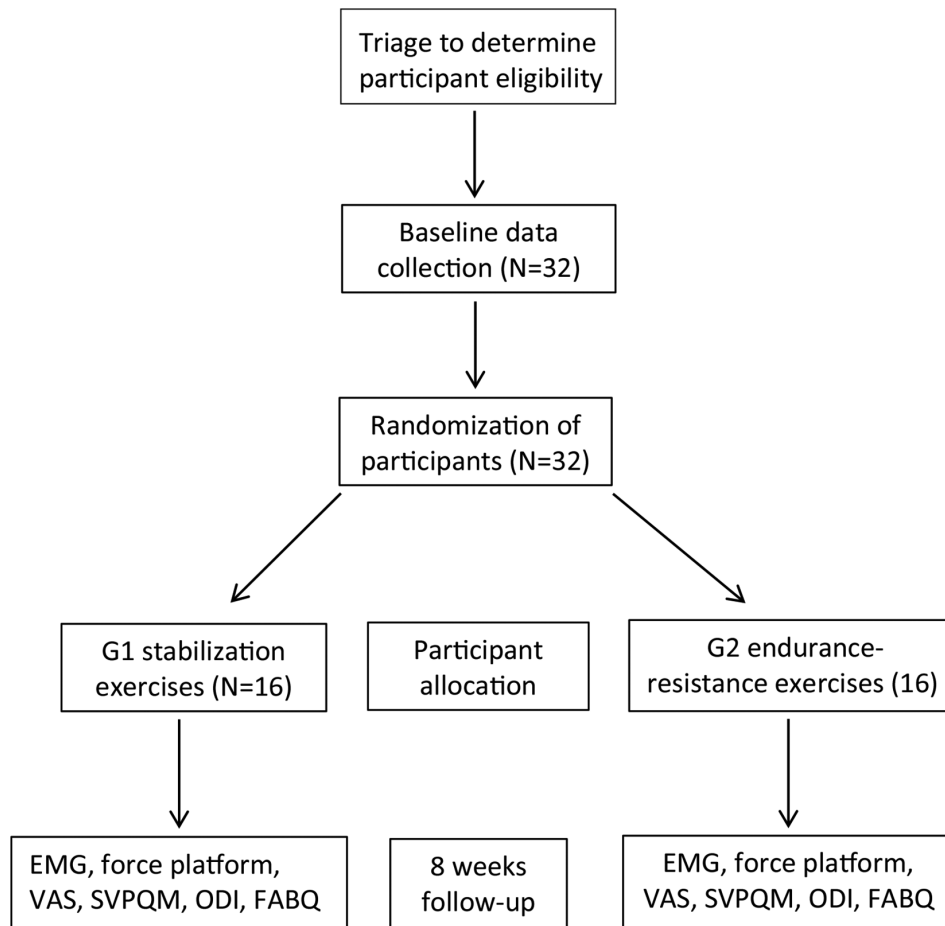


Figure 1 Study flowchart. EMG, Electromyography; FABQ, Fear-Avoidance Beliefs Questionnaire; ODI, Oswestry Disability Index; SVPQM, Short Version of McGill Pain Questionnaire; VAS, Visual Analogue Scale.

Experimental protocol

Balance sitting task (BSIT)

During the BSIT performance, the EMG back muscles will be measured. The athlete will be sitting on a Swiss ball where he must maintain balance with one foot supported on the ground and the other raised. The arms can be raised beside the trunk to maintain balance. Three measures of balance will be computed for each lower limb three times. Acquisitions will be 30 s each with a rest of 30 s.¹⁰

An appropriately sized Swiss ball will be used and adjusted in accordance with each subject's height: subjects with a height between 150 and 165 cm use a 55 cm ball, those with a height between 165 and 180 cm use a 65 cm ball and those with a height greater than 180 cm use a 75 cm ball.²⁵ The Swiss ball will also be inflated according to the subject's weight, so that when a subject is sitting erect and centred on the ball, with feet together and on the ground, the subject's hips and knees will be flexed approximately 90° and the thighs parallel to the floor.²⁵

Balance standing task (BSTT) across four conditions

The BSTT will be performed in association with EMG back muscles. All athletes will complete five balance

tests, barefoot, on a force platform (BIOMECH 400, EMG System) with the arms parallel to the trunk. A blinded and trained evaluator (physiotherapist) with our experimental protocol will perform all tests. The balance conditions will be presented randomly to participants as follows:

1. One-legged stance (preferred leg) with eyes open.
2. One-legged stance (preferred leg) with eyes closed.
3. One-legged stance with knee flexion of 30° (preferred leg) with eyes open.
4. One-legged stance with knee flexion of 30° (preferred leg) with eyes closed.

The position of the feet will be standardised using a tape marker on the force platform. The participants will perform three 30 s trials each task, with 30 s of rest between trials.^{21 23}

Trunk weight measurement (TWM)

The TWM is initially measured to adjust the load training protocol. To evaluate the TWM, a 45° Roman chair (Nakagym SP) and a 0–200 kgf load cell (SF01, EMG system of Brazil) will be used. The load cell will be attached with a chain from the ceiling to a nylon torso harness at the medium thoracic region of the participant.²⁶ The lower body will be fixed in the Roman chair

and the upper body will be suspended by the chain; thus, the athlete will be informed to completely relax their back muscles. The trunk weight will be computed in Newtons (N).²⁶

Lumbar muscles, Maximum Voluntary Isometric Contraction (MVIC)

To evaluate the maximal strength of the back extensors muscles, a 45° Roman chair (Nakagym, SP) will be used. A load cell (SF01, EMG system of Brazil) will be used, with a capacity of 0–200 kgf, attached to a Roman chair near to the floor with a chain and to a nylon torso harness, equipped with a ring at the mid-sternal region to measure the maximum strength of the back extensors (in Newtons: N).²⁶ The participants will perform three MVIC of the back extensors in a horizontal position, with a 3 min rest between trials. The peak across MVICs will be retained for subsequent analyses.²⁶

Lumbar muscle fatigue, Dynamic Back Endurance Test (DBET)

Participants will perform the DBET in a 45° Roman chair with their trunks unsupported. The participants will start the exercise with the trunk in neutral position. They will be encouraged to perform flexion-extension trunk cycles according to an indicator bar positioned to achieve a range of motion of approximately 45°. Each flexion–extension cycle lasts 4 s (2 s of flexion and 2 s of extension), paced with a metronome (Dolphin digital metronome, UK, using 30/bpm). Verbal feedback will be provided by the evaluator during the test. The participants will be instructed to perform trunk flexion-extension cycles up to the maximal number of repetitions possible until exhaustion.²⁶ This test is performed at 50% MVIC of the back extensor muscles.²⁶

In the present study, from the DBET, only the median frequency (MF) will be measured. MF is estimated as the best and most reliable fatigue index used to assess back muscle fatigue (ICC>0.90 and SEM=5%).^{26 27} The magnitude of the electromyographic spectral content will be evaluated by the MF value of the power spectra (Short-fast Fourier transform, Hanning window processing).^{26 27} MF will be calculated in successive time windows (50% overlapped) of 250 ms for the total contraction time in the fatigue protocol condition. A least squares linear regression analysis will then be applied to the MF time series to calculate the rate of decline in MF over time (MF/time slope). The slope from this relationship will then be divided by the corresponding intercept value (obtained from linear regression analysis) and multiplied by 100 to yield the normalised EMG index of muscle fatigue (NMFslp); this procedure has been shown to control for subcutaneous tissue thickness differences between participants.²⁶ The EMG data processing will be performed using EMG work analysis from the Delsys system (V.4.0, Delsys, Massachusetts, USA) and MATLAB subroutines (V.8.0; The MathWorks, Natick, Massachusetts, USA, release 14).

To evaluate the perception of lumbar muscle fatigue before and after training, the BORG CR10-scale will be used. This scale has been validated for use in the context of lumbar fatigue and in individuals with and without CLBP.²⁸ The scale varies from 0 to 10, with 0 being the total absence of muscular fatigue and 10 being its maximum exhaustion. The Borg CR10-scale values considered are: 3 is moderate, 5 is strong, 7 is very strong, 10 is extremely strong (almost maximal) and up to 10 is maximal. Individuals will be familiarised with the scale before starting the training. The BORG CR10-scale will be used as soon as the lumbar resistance test is finished.²⁸ The VAS will be used to evaluate the intensity of pain before and after the test; if the participant to refer pain exacerbation during the execution (EVA 7 or higher), the test will be stopped immediately. A new test data will be scheduled.

Twenty meter shuttle run test (20 m SRT)

The 20 m SRT is a functional test. Twenty meters will be used for the total test distance, where the participant must run as fast as possible. Two taped lines are fixed on the ground positioned 6.7 m apart. To complete the test, each athlete must run the 6.7 m distance between the lines for three times, coming and going as fast as the athlete can. Crossing the lines, the athlete immediately bends down, touches the ground with his preferred hand, gets up and runs back to the other opposite line. An examiner is posted beside the end line to time the end of the test. Athletes without CLBP perform the test in 5.79±0.004 s, while in athletes with CLBP, the time is 6.25±0.11 s.²⁹ The time difference as small as 0.3 s is considered to be clinically significant (power 0.80).²⁹ A difference in performance would indicate residual functional deficits during acceleration, braking, bending and extend the lumbar spine.²⁹ This test will be evaluated whether the performance in a timed functional drill, on average, will be changed and show differences between G1 and G2 after the treatments. A Casio HS-3V-1RDT chronometer will be used.

Exercise interventions

The physiotherapists responsible for the treatments (stabilisation or endurance-resistance exercises) will be trained by a member of the research team (AN), who has 25 years of experience in orthopaedics and sports physical therapy. To ensure standardisation, every physiotherapist will receive a 20 hours course (lecture) and will have the opportunity to practice both treatment protocols over a 1-month period with supervision from the members of the research team in the UNOPAR Physical Therapy Clinic. The principal investigator will also periodically audit the interventions through direct oversight during treatment sessions. All treatments in G1 and G2 will be individualised and realised at the UNOPAR Physical Therapy Clinic.

The G1 group will perform the 8 week LMSE programme (two 50 min sessions/week) and this will

Table 1 The exercises program phases (G1- LMSE).

Phase I	Pain management and motor control of deep muscles (2 weeks max)
Phase II	Beginning impairment and functional level (initiation of exercises with emphasis on quality of movement control)
Phase III	Moderate/Advanced impairment and functional level (endurance development with emphasis on quantity)

be provided to the athletes with CLBP in local physiotherapy clinics, without allowing any cointervention. The treatment sessions will be separated by at least 48 hours. The exercise programme will focus on the motor control of the deep trunk muscles, followed by gradual inclusion of overloading exercises designed to improve endurance and strength of the abdominal and back extensor muscles. The exercise programme consists of the three phases given in [table 1](#).³⁰

Exercise Program ([table 2](#)).³⁰

The physiotherapists will be responsible for making the decision to progress the patient to the next exercise phase based in patient intensity pain related (EVA), observation the quality of the motor control exercise execution (lumbar stabilisation), to the overload and fatigue during the exercises the BORG CR10-scale will be used.²⁸ At the beginning and during the treatment sessions, participants with EVA=4 or lower value carry out the treatment normally. Those with EVA=5 and 6 will try to execute the first series of treatment, if it is possible to perform it without worsening, and they will finish the other two planned series; if it is not possible to perform it, the treatment will be interrupted only for the day and they will return in the next schedule session. Last, with EVA=7 or higher value, treatment will be suspended only for the day and they will return at the next schedule session. Concerning to overload and fatigue during the exercises, the participants with BORG CR10-scale 3 to 5

will increase the overload exercise execution, with answer 6 and 7, the athletes will keep the same exercise series and with answer 8 or above, the overload exercise execution will decrease.

The participants in G2 will also carry out BERE treatment twice a week for a total of 8 weeks (two 50 min session/week). The treatment sessions will be separated by at least 48 hours. G2 participants perform trunk flexion-extension cycles on a 45° Roman chair machine and perform 3 sets of exercises, with a 1 min rest interval between each set as recommended for local muscular endurance by the American College of Sports Medicine (ACSM).³¹ Participants will perform the exercise with hands on opposite shoulders, while working with a range of motion of 45° as for the DBET.²⁶ Participants will make 15–20 repetitions per exercise, which is in accordance with the ACSM guidelines for endurance gains.³¹ Trunk movement speed (flexion-extension) will be controlled by a metronome (the same frequency used in the DBET) supplemented by verbal encouragements and feedback from the physiotherapist.²⁶ A trained professional will be blinded to the evaluation measures conducted at the BERE training. The initial load on the first day of training will be 50% of the load in the first tests. The participants will be encouraged to perform as many repetitions as possible, up to 20 repetitions on the day of training. As soon as 20 repetitions will be reached, intensity will be increased by 5%, through external washers crossing the trunk, for the next set. The same progression strategy will be used throughout the 8 weeks of treatment. If the participant is unable to perform a minimum of 15 repetitions, the load will be decreased by 5%.²⁶ To evaluate the perception of lumbar muscle fatigue before and after each treatment, the BORG CR10-scale will be used in the same way as in G1.²⁸ EVA will be used to quantify pain intensity at the beginning and during the treatment sessions with identical G1 procedure.

Table 2 The Exercises Program (G1- LSME).

Lumbar stabilisation	(1) Adopt normal breathing (never hold your breath). (2) This part of the exercise involving a movement or support of a position must be performed while exhaling.
Motor control exercises	(1) Pelvic tilt: Flatten lower back to the floor or wall, 5–10 s hold in neutral position, 10 repetitions (reps) through pain free range. Progress to pelvic tilt with controlled breathing. (2) ADIM: Pull the navel in towards the spine and then to the head ('J' movement). Able to perform 30 s hold on the left and right sides with normal breathing. (3) Multifidus (prone over pillow at lower abdomen): Swell lower back muscles. 10 s hold × 10 reps.
Overload exercises	Curl-ups (flexion): ADIM + Hold shoulder blades off the ground (or mattress). Heel slides (flexion): ADIM + Swell lower back muscles. Seated hip flexion (flexion): ADIM + Maintain lumbar region in neutral position. Dead bug (flexion): ADIM + Hold the position with the arm and the opposite leg just above the horizontal position. Bird dog (extension): ADIM + Elevate the arm and opposite leg while maintaining lumbar region in neutral position. Side-bridge (oblique): ADIM + Swell lower back muscles + Elevate hips and maintain the body in straight position. Bridge (extension): ADIM + Elevate hips and maintain the body in upright position. Standing Theraband Exercises (extension): ADIM + Swell lower back muscles + Maintain lumbar region in neutral position while performing the upper body exercise.

ADIM, abdominal drawing-in manoeuvre.

Analysis of effect of treatment

A two-way analysis of variance with repeated measures will be performed to compare the differences between G1 and G2 and times (baseline vs end of 8 weeks measurement) and the effects of interaction (Groups \times Times). A posthoc Tukey test will be used to locate the differences between the groups, if necessary. The ES, using Cohen's *d* for main outcomes, will also be computed if significant differences are present as well as the 95% CI. Analyses will be conducted as intention to treat. The IBM SPSS 19 statistical package (IBM, Armonk, New York, USA) will be used.

Ethics

All participants will be informed about the study procedures, risks, benefits of the investigation and will sign an informed consent form before participating in the trial. The study has been registered on ClinicalTrials.gov (NCT02969785). Data will be stored at UNOPAR, Paraná, Brazil.

DISCUSSION

Potential impact and significance of the study

The treatment of CLBP may consist of different intervention strategies, such as surgery, medication, physical therapy and many others, including acupuncture and yoga. In the general population, physical therapy exercises are beneficial for treating CLBP.³² The different types of physical therapy exercises recommended for the management of CLBP include muscle strengthening, muscle resistance and lumbar stability.^{32–34} The literature reports some evidence that stability and resistance lumbar muscle exercises are beneficial for the general population with CLBP.^{35–36} These two modalities of exercise aim to re-establish function, motor control mechanisms, endurance, stabilisation and balance as well as reduce lumbar pain.^{37–39} On the other hand, the universe of athletes with CLBP is as yet little explored, unknown and still needs answers.⁴⁰ Most likely, both LMSE and BERE will be beneficial for athletes with CLBP, as in the general population or one can be better than the other. No study so far has compared lumbar muscle stabilisation versus lumbar muscle resistance exercises in athletes with CLBP. Our research protocol through measurement of fatigue, balance and functional tests in athletes with CLBP will try to bring some light into this field.²⁴

Contribution to the physical therapy profession and to patients

Our hypothesis is original. It proposes to help clinicians and other researchers in the recognition of the still obscure facets that remain around the problem of CLBP in the sports environment. This trial will elucidate which approach could be better, LMSE or BERE, or whether both will present positive results for improving clinical symptoms and dysfunction in athletes with CLBP. In evidence-based practice, the health professionals will be able to use the future conclusions to best use these two

modalities of therapeutic exercises in the management of athletes with CLBP and the patients may have the prerogative of choice.

Future research

We will compare these two types of CLBP treatment among women athletes, athletes who participate in seated sports and swimming athletes. The results of this study will contribute to future trials that compare their effects against other interventions or, perhaps, the association between different interventions to CLBP in sports physical therapy. The long-term effects of these exercise protocols cannot will be predicted, and future studies will be needed with longer follow-up periods.

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