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Original Article

The effects of adding imagery to therapeutic exercises on pain reduction, flexibility, functional performance, and quality of life in women with chronic low back pain

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Abstract
Background: Mental imagery (MI) is frequently used in rehabilitation, often in stationary settings. However, recent studies indicate that incorporating MI during exercise could substantially alleviate pain. **Purpose:** The objective of this study is to determine whether combining myofascial training with MI is more effective than exercise alone in reducing pain, enhancing flexibility, improving functional performance, and increasing quality of life in women with chronic low back pain (CLBP). **Materials and Methods:** Thirty women were assigned to one of three groups: the "Exercise Group" (EG), the "Exercise plus MI Group" (MIG), and the "Control Group" (CG). The exercise sessions included stretching and self-myofascial release (SMR) using foam rollers (FRs). Both experimental groups (EXGs) performed identical exercises; however, the MIG also received MI instructions during the workouts. Measurements were taken at four time points: baseline, after 9 sessions, after 18 sessions, and 2 weeks after intervention. The assessed variables included pain intensity, hamstring and spinal flexibility, functional performance in daily activity simulations, and quality of life as measured by the RAND SF-36. **Results:** Significant pain reduction was observed only in the MIG. Both EXGs showed significant improvements in flexibility, with MIG achieving some scores superior to those of the CG. Functional performance improved across all tests in both EXGs, with more pronounced gains in the MIG. For the RAND SF-36, the EG showed better results in the "Bodily Pain" dimension. In the "Physical Functioning" dimension, both EXGs demonstrated similar positive results. However, significant improvements in "Vitality" and "Health Change" were observed only in the MIG. **Conclusions:** Myofascial training was effective in reducing pain and improving functional capacity and quality of life in women with CLBP. However, incorporating MI instructions during exercise produced more substantial benefits, suggesting a promising new approach for managing chronic musculoskeletal disorders.
Keywords: Self-myofascial release, foam rollers, rehabilitation, mind-body exercise, stretching

Introduction

Mental Imagery (MI) is a psychological technique that is often used by athletes for performance enhancement and motivation (Volgemute et al., 2023; Watt et al., 2018), and it is nowadays incorporated into exercise, dance and rehabilitation environments (Cumming & Williams, 2013). In all these contexts MI has been mainly investigated outside of practice, being defined as “the imaginary representation of a movement, action, physical skill or situation, without the existence of any simultaneous overt bodily movement, and without the presence of actual external stimuli” (Guillot & Collet, 2008; Hall, 2001; Theodorakis et al., 2015). However, data mainly from the dance field research indicate that MI is also used by dancers during movement (Hanrahan, & Vergeer, 2001; Heiland et al., 2012; Nordin & Cumming, 2007; Overby & Dunn, 2011) while few published studies have also focused on its use exclusively during exercise (Daskalaki et al., 2024a, 2024b, 2022, 2021).

Although the use of MI during physical exercise is a concept that distances from the traditional meaning of MI, it shares some common characteristics with it. For example, the use of MI during training, similar to its use without physical practice, may refer to cognitive and motivational content and functions (Daskalaki et al., 2024a, 2024b, 2022, 2021; Kim & Giacobbi, 2009). According to the “applied model of imagery use in exercise”, the content (i.e. what it is imagined) and functions of MI (i.e. why an individual uses it) are as follows: cognitive specific MI (related to technique), cognitive general (about strategies or routines), motivational specific (about goals, e.g. improved appearance, health, physical condition etc.), motivational general-arousal (about arousal levels, e.g. getting energized or relaxed), and motivational general-mastery (about coping in demanding situations, e.g. to stay focused, not to abandon effort etc.) (Munroe-Chandler & Gammage, 2005). These

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content/functions derive from the Sport Imagery Questionnaire (Hall et al., 1998) and were initially explored in sport but have also been applied to exercise, dance and rehabilitation settings (Cumming & Williams, 2013).

As it is established, the content of images as well as the reasons for using MI during exercise fall in the previous 5 categories of MI (Daskalaki et al., 2021; Kim & Giacobbi, 2009). However, MI during exercise hold also other characteristics, with images that, as content, do not belong to the previous categories: while working out, “images of other places” are often visualized (e.g. the sea, forests, dreamy spaces, summer destinations, etc.), as well as metaphorical images (i.e. realistic or unrealistic images or situations), and also images of “characters/roles” (i.e. the exerciser is transformed with his/her imagination into a different person). It has also been mentioned that MI is used during gym sessions by individuals dealing with musculoskeletal discomforts, being perceived as a helpful technique (Daskalaki et al., 2021). This last remark up opens up new research questions and possibilities, since MI for rehabilitation purposes is usually explored in stillness (Dickstein & Deutsch, 2007). Nevertheless, there are many exercisers whose musculoskeletal dysfunctions (often chronic) do not impose them to stillness (de Araújo Mota et al., 2024). Therefore, it is of great importance to explore if the use of MI while working out offers additional benefits over exercise alone. An interesting finding is that giving MI instructions during exercise was more effective than exercise alone on reducing chronic pain in the neck, upper back and low back (Daskalaki et al., 2022). Considering that low back pain (LBP) is globally the leading cause in years lived with disability (Martinez-Calderon et al., 2022), this finding deserves further research.

“Myofascial training” (Daskalaki et al., 2022), on the other hand, is a kind of exercise training that focuses on muscle fascia and is suggested to include different kinds of stretches and self-myofascial release (SMR) (i.e. self-massage) using devices, e.g. foam rollers (FRs) (Schleip & Muller, 2013). According to some approaches, the intervention on muscle fascia (e.g. SMR with FRs) should be the initial step of a corrective exercise programme (Fiore, 2014), since it is thought to release fascia when being inelastic due to pathology, improve its elasticity and increase joint ROM (Fonta et al., 2021). Previous research focusing on chronic LBP has indicated that SMR either with a Rumble Roller (Ajishma, 2016) or with small balls (Ajishma, 2016; Lee et al., 2017; Oh et al., 2018, 2016) led to a reduction of pain, improvement of physical performance (Ajishma, 2016; Oh et al., 2018, 2016), and improvement of the flexibility of hamstrings and spine (Oh et al., 2018, 2016). These findings indicate the beneficial effects of SMR. It is also suggested that the mindful attention of the individual is directed towards the bodily sensations provoked by the treatment (Schleip, 2015) and a way to accomplish that would be through the use of MI (Abraham et al., 2020). Indeed, fascia-oriented, mind-body exercise modalities, such as Yoga (Schleip, 2015), which are focused on physical, mental and emotional parameters (Dunleavy et al., 2016; Goode et al., 2016) and incorporate MI through the use of various images (Chang et al., 2016), have been shown to be effective in the reduction pain (Martinez-Calderon et al., 2022), the improvement of functional ability (Chang et al., 2016; Holtzmann & Beggs, 2013) and of quality of life (Nambi et al., 2014) in patients with LBP.

According to our knowledge, no previous research using an integrated approach of “myofascial training” (i.e. stretching and SMR) has previously investigated if the provision of MI instructions during exercise could lead to more positive results, than exercise alone, in patients with CLBP. Therefore, the aim of the present research was to investigate if exercise (stretching and SMR with FRs) coupled with MI instructions is more effective than exercise alone to reduce pain and improve flexibility, functional performance and quality of life in women with CLBP. The hypothesis of the study was that both programs would be effective on improving the targeted variables but the addition of MI in the same exercise program would lead to more pronounced results.

Materials & Methods

Participants

This research is part of a bigger research (Daskalaki, 2021) held in the Department of Physical Education and Sport Science of Democritus University of Thrace (DUTH), approved by the Ethics in Research Committee of DUTH. It was realized during the period of COVID-19 pandemic, and all participants provided informed consent. In the initial research there were 36 female participants with spinal pain (on the neck and/or upper back and/or low back). For the current report, the data of 30 of the participants who experienced persistent pain specifically in the low back, were taken into account. Therefore, 5 women were excluded and to maintain numeric balance in the groups there was one more additional exclusion from the control group by lot. Finally, 30 women took part in this research who experienced CLBP of a mean intensity of 5 (±1.67) during the last three months as this was measured through an 11-point Numeric Rating Scale (NRS). They had a mean age of 47.54 (±7.96) years (age range: 31-61 years) and their BMI varied between 19.38-34.37 (mean±SD: 25.04±3.99 kg/m^2). They were sedentary and had not previously experienced practicing SMR. They were allocated semi-randomly into three groups, according to the order of appearance: “Exercise Group” (EG), “Exercise plus Mental Imagery Group” (MIG) and “Control Group” (CG). Their characteristics are displayed in Table 1.

Table 1. Characteristics of the participants

	EG (n=10)	MIG (n=10)	CG (n=10)
Age (years)	46.50±7.96	50.75±8.40	46±7.67
BMI (kg/m^2)	25.68±4.60	24.99±4.38	24.39±3.09
Intensity of pain (three months)	4.90±2.23	5.30±1.70	4.80±0.92

Procedures

The sessions for EG and MIG were internet-based (recorded and displayed on YouTube) and the participants could select the day and time of training. The only rule was to work out 3 times weekly for 6 weeks (i.e. 18 sessions). Each exercise session lasted approximately 30 min. The exercise protocol, the FR provided (an EVA FR 90X15 cm) as well as the instructions about the correct execution of the exercises were identical for both experimental groups. The differences were that: a) for MIG there were MI instructions while executing the exercises, b) the videos for EG were recorded in a gym, while for MIG in different places (e.g. sea, port, garden, pool, nature etc.). CG did not participate in organized physical activity for the whole duration of the intervention.

Exercise Protocol

The exercise protocol used is detailed in Daskalaki (2021) and comprised of stretching and SMR with FRs. Various types of stretching were used, including whole-body stretches (for the Superficial Front and Back Lines, and the Lateral and Spiral Lines) as these are described in the theory of Anatomy Trains (Myers, 2009), as well as stretches for isolated muscle groups. The stretches were static, dynamic, "moving" (i.e. sequences of movements), as well as improvisational (i.e. the exerciser could stretch the parts she felt like). The exercises performed with the FR are displayed in Table 2.

Table 2. Exercises performed with the foam roller

Muscle area	Number and duration of rolls	Number of sessions
Glutei	5 full rolls (40 sec)	5
Hip abductors/piriformis 1 (both feet on the ground) 1	5 full rolls (40 sec) per leg	5
Hip abductors/piriformis 2 (one foot crossed on top of the other)	6 full rolls (48 sec) per leg	6
Hamstrings 1	8 full rolls with 15 sec of break after the 4th roll (64 sec)	5
Hamstrings 2	4 full rolls, 15 sec of break, and 4 full rolls multi-directionally	6
Hip adductors	7 full rolls (56 sec) per leg	6
Ankle Plantarflexors 1	8 full rolls with 15 sec of break after the 4th roll (64 sec)	3
Ankle Plantarflexors 2	4 full rolls, 15 sec of break, and 4 full rolls multi-directionally	3
Quadriceps 1	7 full rolls (56 sec)	6
Quadriceps 2	7 full rolls (56 sec), Cobra (20 sec), and 4 full rolls multi-directionally	6
Low Back	6 full rolls (48 sec)	11
Upper Back	5 full rolls (40 sec)	11
Low Back	Personally selected pace (1 min)	4
Upper Back	Personally selected pace (50 sec)	4
Plantar fascia	Approximately 14 rolls (1 min)	5
Relaxation on FR	3.50 min.	13

Imagery Instructions for MIG

Imagery instructions were based on a new instructing methodology inspired by MI techniques that relied on methods used by performing arts practitioners. The methodology is presented in detail in Daskalaki (2021) (in Greek, with all the instructions given) and Daskalaki et al. (2022) (in English, summarized). It can be used by fitness instructors as a point of reference to create mental "scenarios" (little stories)/specific instructions either for the whole session or for an exercise or specific movements in it, depending on the goals. The whole methodology is based on certain "principles" often used by actors and dancers. At the core of this methodology lie the "principle of imagination" (i.e. the use of imagination) and the "principle of the extra-ordinary" (i.e. the ability to develop a "paradoxical" way of thinking, as artists do). The images used may be realistic (e.g. imagine that you are in the water) or unrealistic (e.g. imagine that your body is a bright source of energy). The mental scenarios were created by using techniques employed in the theatre such as: a) the "given circumstances" which in the theatre world are "all the circumstances given to an actor to take into account as he/she creates the role" (Norvelle, 1962; Stanislavski, 1977); b) the use of "magic if" which demands from the individual to "believe" in this new fictional reality, passing from "the plane of actual reality into the plane of another life, created and imagined by himself/herself" (Norvelle, 1962; Stanislavski, 1980); c) description of specific "objectives" and/or "super-objectives" to the individuals while moving (Chekhov, 2008) (i.e. the "principle of personal justification of exercises" according to which exercises are treated as motivated "psychosomatic actions", caused by an inner stimulus and have a specific goal). Other principles which guided the instructions focused on "complete concentration", "total body control and conscious movement", "non-mechanical movement" (i.e. observing the bodily sensations while moving), "eliminating unnecessary muscular tension", "maximum energy", "total involvement" of the whole self in the exercise, i.e. body, mind, and soul, "multilateral breathing" (i.e. use thoracic, lateral, diaphragmatic or full breathing, according to the exercise) (Grotowski, 1982), "radiation" or/and "absorption" (i.e to radiate towards the world or absorb from the environment everything positive), "continuous flow of energy", and "pleasure" (i.e. to take pleasure while exercising). The images that addressed the principles were of all known types of MI (i.e. cognitive specific, cognitive general, motivational specific, motivational general-arousal and motivational general-mastery) while also images of other places, metaphorical images, and images of "characters/roles" were used. To give an example, instructions that addressed the "principle of eliminating unnecessary muscular tension" were: "Imagine that you move in hot water which makes your muscles relax more and more with every single move you make" or "Imagine that you are lying on hot sand which releases the 'frozen', 'blocked' areas of your body". Finally, in two sessions participants were encouraged to use "personal imagery" i.e. to form their own mental images.

Measurements

The measurements were executed before the intervention (Baseline Measurement), after 3 weeks, i.e., after the first 9 sessions (Middle Measurement), after 6 weeks, i.e. after 18 sessions (Final Measurement) and 2 weeks after (Follow-up Measurement) and included the variables displayed below.

Intensity of Pain "today"

To assess the intensity of LBP "today" an 11-point NRS was used, since these scales are valid and reliable (MacDermid et al., 2013) and are proposed as the most appropriate self-report measures for LBP patients (Chiarotto et al., 2017; Salaffi et al., 2015). The NRS used consisted of a numbered line from 0 (at the left end of the scale which corresponded to "no pain at all") to 10 (at the right end which corresponded to "unbearable pain"). Participants were asked to circle the number that corresponded to the intensity of their LBP "today".

Modified Fingertip-to-Floor Distance Test (MFFD)

The combined ROM of the lumbar spine and the hips was evaluated by the MFFD, which has been tested in patients with LBP and has excellent validity (Perret et al. 2001) and very high reliability (Gauvin et al., 1990; Perret et al., 2001). Its difference from the "Fingertip-Floor Distance Test" is that the subject performs the forward flexion of the spine while standing on an elevated surface, an adaptation that allows the achievement of maximum possible flexion in subjects who have the ability to overcome the ground (Frost et al., 1982; Gauvin et al., 1990). The participant stood on a step, with the feet close together, the knees straight, the palmar surface of one palm on the dorsal surface of the other and the middle fingers joined, and performed a maximal pain-free spinal flexion, attempting to approach the ground. If the participant did not touch the step, the value was recorded as positive (distance from the middle finger to the step) (e.g. +5cm). If the fingers exceeded the step, the value was recorded as negative (distance from the middle finger to the step) (e.g. -5cm). If the fingers touched but did not exceed the step, the value was recorded as zero (0) (Frost et al., 1982). Each participant performed the test twice, with a self-selected break between trial. Performance in this test was calculated with a tape measure and was the average of the two tests in cm.

Straight Leg Raise Test

The hip ROM was evaluated with the "Straight Leg Raise Test" which is used very often in LBP patients and has excellent reliability (Malliou et al., 2006; Neto et al., 2015). The participant was supine, with both lower limbs relaxed on the ground. The researcher began to raise the subject's lower extremity, with the hip in a neutral position, the knee extended and the ankle relaxed. The movement was stopped when either the researcher found great resistance or pelvic rotation was observed (Neto et al., 2015) or when the participant requested it. The measurement was made with a plastic goniometer with axes 35cm long and protractor graduation 0°-360° per 1°. The center of the goniometer was placed on the greater trochanter, with one arm aligned with the outer femoral condyle and the other with the long axis of the trunk (Beneka et al., 2015; Neto et al., 2015). For each lower extremity, two consecutive measurements were made, always starting from the right leg. Performance on this test was the average of the two tests for each leg separately in degrees.

Functional tests that simulate activities of daily living

In the next three tests, a total of two trials were performed with as much rest as each participant needed, and the score was the average of the two trials in seconds and tenths of a second. Timing started with "go" and stopped depending on the test. The participant was encouraged to perform each test as quickly as possible, but in a safe and pain-free manner. A Mio Coach PC3830A timer was used for timing.

Standing-to-Prone Test

This test has been used in Bakhtiary, Safavi-Farokhi, & Rezasoltani (2005) where it was referred to as "Laying Prone on the Floor from the Standing Position". In the present research, the participant started from a standing position, with the feet at a comfortable distance and the arms relaxed next to the torso. On the command "go" she should descend as fast as she could to the ground and assume a prone position, bringing the dorsal surface of her palms under the forehead. The timing stopped when the participant stopped in the indicated position.

5 Times Sit-to-Stand Test

The 5 Times "Sit-to-Stand Test" has been tested in patients with LBP and has an acceptable sensitivity to change (AUC= 0.70) (Andersson et al., 2010). The participant was seated in the middle of the chair, without contact with the backrest, with her arms crossed in front of her chest, and her feet flat on the ground. She was instructed to try standing up and sitting down from the chair once (or more if she wished) in order to place her feet comfortably to perform this movement, since the soles of the feet should stay still during the test. On the command "go", she had to start the movement which consisted of five consecutive movements of standing up (until the knees were stretched) and returning to a sitting position in the chair, as fast as possible. Timing stopped the fifth time the participant's glutes touched the chair.

Timed Up-and-Go Test

This test has very good reliability (ICC=0.98) (Simmonds et al., 1998). The participant was seated in a chair, with her arms relaxed at her side. With "Go" she had to stand up, walk to a mark placed on the ground at a distance of three meters, turn, return to the chair and sit down again. Timing stopped when the participant's glutes touched the chair.

RAND SF-36

The RAND SF-36 is a questionnaire that assesses quality of life addressing specific aspects of physical and mental health and is the most frequently used in research focusing on LBP internationally (Chiarotto et al., 2017). Its Greek version has high validity and reliability (Pappa et al., 2006). It includes 8 dimensions, each consisting of 2-10 questions, and one single question which refers to "Health Change" (total: 36 questions). With the exception of the latter and also of "General Health", the questions of the other scales, refer to the 4 past weeks. In the present research, the scoring proposed by Hays, Sherbourne, & Mazel (1993) was chosen, i.e. the answers are scored from 0 to 100%, and overall performance on each of the dimensions is calculated as a percentage. In this case, it is recommended that the questionnaire be referred to as the RAND SF-36. The dimensions and their respective questions investigate the following (Hays et al., 1993; Pappa et al., 2006; Ware et al., 1993): 1) "Physical Functioning": limitations due to health when performing athletic or everyday physical activities, of a vigorous, moderate or mild intensity; 2) "Bodily Pain": how much bodily pain the respondent felt and how much the pain affected his/her normal work both outside the home as well as inside; 3) "Role limitations due to physical health": limitations in the performance of professional or daily activities due to the state of physical health; 4) "General health": how the respondent evaluates his/her health (from poor to excellent); 5) "Role limitations due to emotional problems": if work or daily activities were reduced due to emotional problems (e.g. feeling depression or anxiety); 6) "Social Functioning": difficulty in engaging in social activities due to physical health and/or emotional problems; 7) "Energy/fatigue (Vitality)": how the respondent was feeling in terms of energy (i.e. full of prep, lot of energy) or tiredness (i.e. tired, worn out); 8) "Emotional well-being" (mental health): how the respondent felt and what his/her mood was, with an emphasis on feelings of irritation, psychological collapse, despair/melancholy or, on the contrary, happiness, calmness and peace; 9) "Health Change": a single question that asks the respondent to rate his/her general health status compared to one year ago. From the previous dimensions, the first 4 are thought to refer to the "Physical Component" and the subsequent 4 to the "Mental Component" of Quality of Life.

Statistical Analysis

The data were analyzed with SPSS, and a two-way repeated-measures Anova (3X4) was used. The independent variable was "group" (EG, MIG, CG), the dependent variable was "score" (in the relative variable examined) and the repeated factor was "time" (*i.e.,* score in baseline measurement, middle measurement, final measurement and follow-up measurement). Analysis for all variables where a statistically significant interaction between time*group was documented on the score was continued performing pairwise comparisons (adjustment for multiple comparisons: Bonferroni). Specifically, for every variable, the interaction between time*group was controlled: a) for every level of the factor "group", to control if there was a statistically significant effect of the factor "time" on the respective variable, i.e. if there were within-group (intra-group) differences in the four different time points and for which group, and b) for every level of the factor "time", to control if there was a statistically significant effect of the factor "group" on the respective variable, i.e. if there were between-groups (inter-group) differences and in which time point. The statistical significance level was set at 0.05 ($p<0.05$).

Results

Intensity of Pain, Flexibility Tests and Functional Performance Tests

A statistically significant interaction between time*group was documented in the intensity of pain (NRS) and in all flexibility and functional performance tests: at the score of NRS ($F_{6,81}$ =2.633; p=0.022 <0.00), MFFD ($F_{6,78}$ =3.589; p=0.003 <0.00), Straight Leg Raise Test (Right) ($F_{6,78}$ =5.518; p=0.001 <0.00), Straight Leg Raise Test (Left) ($F_{6,78}$ =13.429; p=0.001 <0.00), 5 Times Sit to Stand Test ($F_{6,78}$ =4.164; p=0.010 <0.00), Timed Up and Go Test ($F_{6,81}$ =3.690; p=0.003 <0.00) and Standing to Prone Test ($F_{6,78}$ =9.382; p=0.001 <0.00).

Post-hoc tests revealed a statistically significant effect of the factor "time" (within-groups) ($p<0.05$) for: a) "intensity of pain": in MIG in all measurements (Table 3), b) MFFD: in EG in all measurements and in MIG in the final measurement, c) Straight Leg Raise Test (right and left leg) in EG and MIG in all measurements (Table 4), d) Standing to Prone Test in EG and MIG in all measurements compared to baseline and in the final measurement compared to the middle measurement; additionally, in EG in the follow-up measurement compared to the final measurement and in MIG, in the follow-up measurement compared to the middle measurement , e) 5 Times Sit-to-Stand Test in EG and MIG in all measurements compared to baseline and in MIG, additionally, in the final and follow-up measurement compared to the middle measurement, f) in Timed Up and Go Test in EG and MIG in all measurements compared to baseline (Table 5).

Post-hoc tests revealed a statistically significant effect of the factor "group" (between-groups) ($p<0.05$) for: a) Straight Leg Raise Test (right and left leg), where MIG had a statistically significant better score than CG in the final and follow-up measurements (Table 4), b) Standing to Prone Test, where EI and MIG had a statistically significant higher score than CG in the final measurement; additionally, MIG had a statistically significant score than CG at the follow-up measurement, c) Timed Up and Go Test where MIG had a statistically significant higher performance than CG in the final and follow-up measurements (Table 5).

Table 3. Intensity of Pain

	EG	MIG	CG
Baseline Measurement	3.50±2.99	5.20±1.40	3.60±1.77
Middle Measurement	2.90±1.73	3.20±1.39^{*b}	3.60±1.95
Final Measurement	2.10±2.13	2.60±1.77^{*b}	3.50±2.32
Follow-Up Measurement	2.70±2.16	2.80±1.75^{*b}	4.00±2.05

*within groups (b: compared to baseline). MIG: $F_{3,25}$=5.839, p=0.004 <0.05

Table 4. Flexibility Tests

Modified Fingertip to Floor Distance

	EG	MIG	CG
Baseline Measurement	4.86±7.24	7.45±8.31	4.80±8.65
Middle Measurement	1.96±7.03^{*b}	4.40±9.73	5.73±10.62
Final Measurement	-2.63±4.90^{*b}	2.94±10.24^{*b}	5.24±10.57
Follow-Up Measurement	-.1250±5.80^{*b}	4.14±10.17	6.24±13.68

*within groups (compared to b: baseline) EG; $F_{3,24}$=9.536, p=0.001 <0.05. MIG; $F_{3,24}$=3.866, p=0.022 <0.05)

Straight Leg Raise Test (Right Leg)

	EG	MIG	CG
Baseline Measurement	77±11.20	79.88±7.14	79.55±13.08
Middle Measurement	86.20±3.70^{*b}	90.50±11.04^{*b}	78.25±14.15
Final Measurement	91.25±5.43^{*b}	93.72±12.98^{*b,**CG}	78.50±14.11
Follow-Up Measurement	86.95±8.16^{*b}	94.61±12.44^{*b,**CG}	79.05±13.90

*within groups (compared to b: baseline) (EG; $F_{3,24}$=10.143 p=0.001 <0.05. MIG; $F_{3,24}$=8.418, p=0.001 <0.05)
**between groups: final measurement ($F_{2,26}$=4.954, p=0.015 <0.05), follow-up measurement ($F_{2,26}$=4.176, p=0.027 <0.05)

Straight Leg Raise Test (Left Leg)

	EG	MIG	CG
Baseline Measurement	74.95±9.32	80.11±8.14	82.20±14.35
Middle Measurement	88.25±5.90^{*b}	93.00±9.57^{*b}	80.50±14.73
Final Measurement	90.95±3.81^{*b}	93.72±7.66^{*b,**CG}	79.90±16.67
Follow-Up Measurement	89.60±5.43^{*b}	92.72±7.84^{*b,**CG}	80.65±14.70

*within groups (compared to b: baseline) (EG: $F_{3,24}$=28.002, p=0.001 <0.05; MIG: $F_{3,24}$=18.257, p=0.001 <0.05)
$**^{CG}$*between groups (compared to CG)*: final measurement ($F_{2,26}$=4.349, p=0.023 <0.05), follow-up ($F_{2,26}$=3.652, p=0.040 <0.05).

Table 5. Functional Performance Tests

Standing to Prone Test

	EG	MIG	CG
Baseline Measurement	3.76±0.74	3.25±0.67	3.56±0.63
Middle Measurement	3.03±0.62^{*b}	2.84±0.67^{*b}	3.41±0.72
Final Measurement	2.61±0.40$^{*b,m, **CG}$	2.52±0.52$^{*b,m, **CG}$	3.40±0.71
Follow-Up Measurement	2.80±0.36^{*b,f}	2.49±0.63^{*b,m,**CG}	3.38±0.69

*within groups (compared to b: baseline, m: middle, f: final) (EG: $F_{3,24}$=28.311, p=0.001 <0.05; MIG: $F_{3,24}$=11.569, p=0.001 <0.05)
$**^{CG}$between groups (compared to CG): final measurement: ($F_{2,26}$=7.223, p=0.003 <0.05), follow-up measurement ($F_{2,26}$=5.864, p=0.008 <0.05)

5 Times Sit-to-Stand Test

	EG	MIG	CG
Baseline Measurement	11.40±2.00	11.58±3.52	11.46±3.89
Middle Measurement	9.73±1.88^{*b}	9.92±2.39^{*b}	11.04±3.90
Final Measurement	9.12±1.85^{*b}	8.65±1.60^{*b,m}	10.79±3.91
Follow-Up Measurement	8.9±1.69^{*b}	8.39±1.68^{*b,m}	10.87±4.15

*within groups (compared to b: baseline, m: middle) (EG: $F_{3,24}$=6.993, p=0.002 <0.05; MIG: $F_{3,24}$=12.498, p=0.001 <0.05)

Timed Up and Go Test			
	EG	**AG**	**CG**
Baseline Measurement	6.23±0.63	5.87±1.42	6.32±0.6
Middle Measurement	5.75±0.65^{*b}	5.51±1.12^{*b}	6.20±0.63
Final Measurement	5.39±0.81^{*b}	5.27±0.87$^{*b, **CG}$	6.27±0.70
Follow-Up Measurement	5.51±0.66^{*b}	5.26±1.08$^{*b, **CG}$	6.30±0.74

*within groups (compared to b: baseline) (EG: $F_{3,25}$=8.604, p=0.001 <0.05; MIG: $F_{3,25}$=5.033, p=0.007 <0.05)
**^{CG}between groups (compared to CG): final measurement ($F_{2,27}$=4.664, p=0.018 <0.05), follow-up measurement ($F_{2,27}$=4.664, p=0.018 <0.05)

Quality of Life (RAND SF-36)

Regarding RAND SF-36, a statistically significant interaction between time*group was documented for: a) two dimensions of the "Physical Component", i.e. Physical Functioning ($F_{6,81}$=3.442, p=0.004 <0.05), and Bodily Pain ($F_{6,81}$=3.053, p=0.010 <0.05), b) one dimension of the "Mental Component", i.e. Energy/Fatigue (Vitality) ($F_{6,81}$=3.597, p=0.003 < 0.05) and c) in Health Change ($F_{6,81}$=2.655, p=0.021 < 0.05). For the remaining dimensions of RAND-36 (Role limitations due to physical health, General Health, Role limitations due to emotional problems, Social Functioning, and Emotional well-being) neither a statistically significant interaction between time*group was documented nor a main effect of the factor "time" or of the factor "group" (p >0.05).

Post-hoc tests revealed a statistically significant effect of the factor "time" (within-groups) (p<0.05) for: a) Physical Functioning: In EG there was a statistically significant difference in the final and follow-up measurements compared to the middle measurement and in MIG in the follow-up measurement compared to the baseline measurement, and in the final and follow-up measurement compared to the middle measurement, b) Bodily Pain: In EG there was a statistically significant difference in the final measurement compared to baseline, and in MIG in the final and follow-up measurement compared to the middle measurement, c) Energy/Fatigue (Vitality): In MIG there was a statistically significant difference in all measurements compared to baseline, d) Health Change: In MIG there was a statistically significant difference in the score in the final and follow-up measurement compared to baseline and the middle measurement (Table 6).

Post-hoc tests revealed a statistically significant effect of the factor "group" (between-groups) (p<0.05) for: a) Bodily Pain where EG had statistically significant higher score than CG (Table 6).

Table 6. Quality of Life (RAND SF-36)

Physical Functioning			
	EG	**MIG**	**CG**
Baseline Measurement	70.50±15.71	74.00±18.23	80.00±8.50
Middle Measurement	72.00±14.94	74.50±13.22	81.50±11.56
Final Measurement	81.00±11.73^{*m}	86.00±11.00^{*m}	78.50±13.34
Follow-Up Measurement	83.00±10.05^{*m}	88.00±10.05$^{*b, *m}$	79.00±13.08

*within groups (compared to b: baseline, m: middle measurement) (EG: $F_{3,25}$=5.761, p <0.05; MIG: $F_{3,25}$=8.713, p <0.05)

Bodily Pain			
	EG	**AG**	**CG**
Baseline Measurement	63.00±15.22	56.75±17.87	60.75±21.21
Middle Measurement	72.00±14.03	51.25±21.58	60.75±23.86
Final Measurement	80.00±14.29^{*b,**CG}	69.00±19.05^{*m}	57.50±19.48
Follow-Up Measurement	76.75±14.67	67.00±19.14^{*m}	56.50±19.87

**within groups (compared to b: baseline),* (EG: $F_{3,25}$=3.277, p=0.038 <0.05; MIG: $F_{3,25}$=4.039, p=0.018 <0.05)
***^{CG}between groups (compared to CG)* ($F_{2,27}$=4.014, p=0.030<0.05).

Role limitations due to physical health			
	EG	**MIG**	**CG**
Baseline Measurement	72.50±29.93	72.50±27.51	72.50±29.93
Middle Measurement	75.00±23.57	90.00±12.91	80.00±25.82
Final Measurement	90.00±31.62	77.50±31.17	75.00±26.35
Follow-Up Measurement	75.00±35.35	85.00±33.74	75.00±28.86
General Health			
	EG	**MIG**	**CG**
Baseline Measurement	70.00±21.34	69.00±12.86	69.00±12.43
Middle Measurement	65.50±20.34	69.00±13.90	69.50±17.55
Final Measurement	76.50±13.34	69.00±15.23	69.50±15.17

Follow-Up Measurement	74.50±18.17	71.50+14.53	69.50±16.06
Energy/Fatigue (Vitality)			
	EG	**MIG**	**CG**
Baseline Measurement	53.00±16.36	45.50±24.88	53.00±14.91
Middle Measurement	53.00±13.37	60.50±16.74^{*b}	54.50±15.17
Final Measurement	62.00±16.86	64.00±18.52^{*b}	49.50±14.42
Follow-Up Measurement	61.00±10.21	66.50±18.11^{*b}	52.50±16.87

**within groups (compared to b: baseline)* ($F_{3,25}$=7.440, p=0.008 <0.05).

Role limitations due to emotional problems			
	EG	**MIG**	**CG**
Baseline Measurement	60.00±34.44	59.90±43.89	66.66±38.50
Middle Measurement	63.30±36.69	63.30±42.90	73.31±26.35
Final Measurement	83.30±36.00	63.30±42.90	56.63±27.49
Follow-Up Measurement	70.01±33.15	80.00±35.83	63.31±33.18
Social Functioning			
	EG	**MIG**	**CG**
Baseline Measurement	77.50±17.48	72.50±27.51	77.50±21.88
Middle Measurement	78.75±17.73	90.00±9.86	81.25±24.47
Final Measurement	85.00±19.36	85.00±20.24	77.50±24.86
Follow-Up Measurement	92.50±13.43	75.00±28.29	77.50±21.08
Emotional well-being			
	EG	**MIG**	**CG**
Baseline Measurement	67.20±13.57	58.80±12.66	62.00±18.11
Middle Measurement	70.80±11.00	66.00±10.37	60.80±16.19
Final Measurement	75.60±8.53	68.40±9.88	56.80±22.92
Follow-Up Measurement	74.40±9.27	70.40±13.35	60.80±21.56
Health Change			
	EG	**MIG**	**CG**
Baseline Measurement	67.50±16.87	52.50±18.45	62.50±24.29
Middle Measurement	67.50±16.87	52.50±14.19	62.50±21.24
Final Measurement	70.00±19.72	70.00±22.97^{*b,m}	65.00±21.08
Follow-Up Measurement	67.50±20.58	75.00±26.35^{*b,m}	67.50±20.58

**within groups (compared to b: baseline, m: middle measurement)* ($F_{3,25}$=4.975, p=0.008 <0.05).

Discussion

According to the results of the present research, between group comparisons did not reveal statistically significant differences between the EG and MIG, but when comparing them to CG there were differences in some variables. There were also within-group improvements in various variables and in different time points according to the group.

Specifically, regarding pain intensity (NRS), only MIG had statistically but also clinically significant improvements in all time points compared to baseline. The clinically significant reduction of pain of MIG, which is considered to be more than 2 points in 11-point NRSs (Childs et al., 2005), reveals that the protocol followed by MIG was effective in reducing LBP intensity in those participants. On the other hand, EG performed better than MIG in the dimension "Bodily Pain" of RAND-SF-36. This could be due to the fact that NRSs and RAND SF-36 are different measures, they had a different recall period (Kamper at el., 2015) while the latter assesses the respondent's pain in a more generic way and is not specifically designed for people with LBP (Christakou et al., 2011).

As for flexibility, in Straight Leg Raise Test of both legs both experimental groups had statistically significant within-group improvements in all time points but MIG had also a statistically significant better score than CG in the final and follow-up measurements, revealing a greater effect of the MI instructions. On the contrary, in MFFD, EG performed better with significant differences in all measurements, contrary to MIG with good performance only in the final measurement.

In relation to the functional performance tests, it appeared that MIG had more prominent improvements. Specifically, concerning within-group improvements, both experimental groups had statistically significant better performance in all 3 functional tests, but MIG, additionally, succeeded, in Standing to Prone Test and in 5-Times Sit to Stand Test to have a statistically significant better score not only in comparison to baseline but also to the middle measurement (whose score was statistically better compared to baseline), revealing an evergrowing progress. Additionally, between-group comparisons revealed a greater effect of the MI instructions since MIG had also a statistically significant better score than CG in the final and follow-up measurements at Timed Up and Go and Standing to Prone Test as opposed to EG which succeeded in between groups comparison only in the final measurement of Standing to Prone Test.

Regarding quality of life, in both groups there was a similar improvement in “Physical Functioning”, nevertheless MIG also exhibited a significant difference in the follow-up measurement compared to baseline. In “Bodily Pain”, although MIG revealed improvements in the two last measurements compared to the middle measurement, only EG had a statistically significant improvement in the final measurement compared to baseline as well as in comparison to CG. On the other hand, only MIG had statistically significant within-group improvements in Energy/Fatigue (Vitality) and Health Change which remained significant till the follow-up measurement.

Resuming these outcomes, it could be sustained that although the exercise protocol alone was effective in generating significant improvements in many of the targeted variables, the addition of MI led to more substantial changes, implying that MI is a useful adjunct in a myofascial training exercise protocol for the improvement of pain, flexibility, functional performance and dimensions of quality of life in women with CLBP.

The fact that the exercise protocol alone produced several significant outcomes could be due to the nature of the intervention which targeted muscle fascia. SMR with FRs has been found to enhance the flexibility of various muscle groups like the quadriceps (Konrad et al., 2022), ankle plantar flexors and hamstrings (Stovern et al., 2019). Previous research has also established that the combination of stretching with SMR with FRs was more effective in increasing the hamstrings’ flexibility than either of these modalities alone (Mohr et al., 2014). Also, Patel, Vyas, & Sheth (2016) have found that SMR on the plantar fascia led to improvement in hamstrings’ flexibility, a finding explained by the theory of myofascial chains, in which it is sustained that strain is not only local but may travel to other parts of the same line (Myers, 2009).

Therefore, the multilateral exercise protocol used in the present research, which used both stretching and SMR for the Superficial Back Line, is probably the reason for the significant acquisitions in hip and lower back ROM. Possible explanations for the chronic effect of these modalities on ROM include the “inactivation” of myofascial trigger points (MTPs), which are often seen in LBP patients in various muscles, i.e. piriformis, medius glutei (Chen & Nizar, 2011; Iglesias-González et al., 2013; Simons, 2002), gluteus maximus, quadratus lumborum, thoracolumbar (Simons, 2002) and lumbar paravertebral muscles (Chen & Nizar, 2011). As it has been reported, MTPs can cause pain and decrease ROM (Gautshi, 2012) and they may be inactivated through stretching as well as massage (Zhuang et al., 2014). The application of pressure is thought to release MTPs (Junker & Stöggl, 2015), alleviate muscular tension, reduce pain (Shariat et al., 2020), and subsequently lead to an increase in flexibility (Junker & Stöggl, 2015). Not having measured pressure pain thresholds or used invasive techniques for the investigation of other muscular and fascial alterations, the precise mechanism for the augmentation of the flexibility remains hypothetical in the present study. However, an increase of flexibility was recorded, and maybe that was the reason why (together with the reduction of “pain today” in MIG and of “Bodily Pain” in EG) the functional performance of both groups also improved.

Examining the different progress of EG and MIG in some variables, it could be sustained that the addition of MI had a positive impact. The more pronounced improvement of MIG in the reduction of pain (NRS) could be due to the fact that the dictation of images that corresponded to principles such as “total body control and conscious movement”, “non-mechanical movement”, “eliminating unnecessary muscular tension” and “total involvement” of the whole self in the exercise, i.e. body, mind, and soul could have led to greater control of the body. Considering that MI can be used at all times and also in stillness, it is probable that the participants of MIG enhanced even more their proprioceptive awareness not only during the sessions but also during their daily movements, correcting faulty movement patterns, and thus succeeding in the limitation of unwanted muscular stress which intensifies pain. Similar arguments with regard to the reduction of pain due to proprioceptive (Efstathiou et al., 2022), kinesthetic and interoceptive awareness have been made for other modalities in which MI is also used like Yoga, Tai Chi and Feldenkrais (Astin et al., 2003; Budhrani-Shani et al., 2016; Dunleavy et al., 2016; Öhman et al., 2011).

Although EG had a better overall performance at MFFD, MIG performed better in the functional tests, preserving the improvements in the follow-up measurements not only within-group (similarly to EG) but additionally in comparison with CG in some tests. Previous research has found that spinal flexion alone (as this is assessed by MFFD) cannot be correlated with other sagittal functional tasks (i.e. stand or sit from a chair), since they challenge the hips and lumbar spine in a different way. For this reason, for a better understanding of impairment and of the movement profile of a patient, more functional tasks are suggested to be performed than spinal flexion alone (Alqhtani et al., 2015), as was done in the present study. Indeed, MIG’s progress in most of the functional tests was continuous from measurement to measurement, revealing an unstoppable significant progress. MIG also maintained till follow-up significant improvements in the dimension “Physical Functioning” of RAND SF-36. Therefore, with regard to functional capacity, it could be sustained that the use of MI techniques produced an additive effect. Research focusing on healthy individuals (e.g. dancers) has already established that the application of MI during movement has an impact on performance outcomes (Heiland et al., 2012; Heiland & Rovetti, 2012). On the other hand, in rehabilitation settings, the use of MI in stillness, aiming to the restoration of the functional mobility, is still doubted and it is argued that MI should be coupled with physical exercises in order to be effective (Zach et al., 2018).

The observation that only the participants of MIG had statistically significant within groups improvements in Energy/Fatigue (Vitality) of RAND SF-36 could be linked to the fact that only them, by means of the "principle of maximum energy", were encouraged to be fully energized while performing the exercises (motivational general-arousal instructions). Increasing Vitality is very important because, feeling energetic rather than tired is associated with more positive emotions in daily life (Mousouli et al., 2014), while the etiology of fatigue is not always clear with individual patients and is often very difficult to manage (Salaffi et al., 2015). It has also been found that there are strong associations between back pain and vitality (Iguti et al., 2021) and the fact that only MIG experienced a clinically significant reduction in pain intensity could explain this outcome as well as its improvement in "Health Change".

A similar improvement was not observed for "General Health" but this could be due to the fact that the participants were not aware of any health problem other than their musculoskeletal issue. Moreover some trainees were skeptical from the very first measurement about the wording of some items of the said scale and stated that they would provide more "neutral" answers: for example, there were comments that it would be difficult for anyone to state that they considered their health to be excellent (a wording that appears in two out of the five questions on the scale) or to compare the personal health status with other people's health, as they are not aware of the actual health status of other individuals (a wording that appears in two questions). As for the other dimensions of RAND-36 (Role limitations due to physical health, Role limitations due to emotional problems, and Emotional well-being), according to the results there was improvement, however not statistically significant. The fact that the research was completed during the COVID-19 pandemic period, during which social distancing and tele-work was imposed, can justify these results.

Considering that LBP is more prevalent in women than in men and more intense in the age of 40-50 years (Mattiuzzi et al., 2020), the results of this research add useful data on the functional rehabilitation of CLBP suggesting the use of MI techniques during therapeutic exercise. Although the exercise protocol alone was beneficial for the participants, the more pronounced results seen when using MI instructions indicate that maybe it is preferable to incorporate this technique, since, apart from other benefits it also has no cost. As it has been hypothesized in the past, alternative forms of exercise may target and influence multiple physiological and psychological processes related to the chronic pain condition, due to their multidimensional nature, and are therefore more beneficial compared to conventional unilateral (monomodal) approaches (Budhrani-Shani et al., 2016).

Conclusions

Myofascial training (stretching and SMR with FRs) proved to be an effective exercise modality for the treatment of LBP patients. However, the use of MI during therapeutic exercise appears to be a promising addition that brings more pronounced positive results in reducing pain, and improving functional capacity and quality of life in women with CLBP. This is an important outcome, when considering that MI is usually explored in stillness. At the same time, the significance of this result lies in the fact that MI can be easily applied since it has no cost. Given that LBP remains worldwide the leading cause in years lived with disability, it is imperative to use every possible way to enhance the effectiveness of therapeutic exercise programmes. Moreover, although the exercise sessions were internet-based and not directly supervised, they still led to substantial improvements in a surprisingly short period of time.

Providing feasible and effective solutions towards integrating exercise into the daily programme is extremely valuable for those individuals who find it difficult to attend face-to-face exercise classes due to heavy schedules, time constraints and other objective restrictions.

The findings of the present study add new scientific data and possibilities in the fields of rehabilitation and MI research, suggesting a new approach in the functional management of chronic musculoskeletal disorders. The addition of MI at a concrete exercise protocol may serve as an alternative way of addressing not only physical but also mental and emotional parameters, providing a mind-body approach which could be adjusted for various types of therapeutic exercise.

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No potential conflicts of interest were reported by the authors.

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