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EFFECTIVENESS OF MYOFASCIAL RELEASE VERSUS MUSCLE ENERGY TECHNIQUE COMBINED WITH EXERCISE ON PAIN, DISABILITY, FEAR AVOIDANCE, AND LUMBAR MOBILITY IN CHRONIC NON-SPECIFIC LOW BACK PAIN: A RANDOMIZED CONTROLLED TRIAL

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Chronic non-specific low back pain; Myofascial release; Muscle energy technique; Exercise therapy; Disability; Fear avoidance; Lumbar mobility; Randomized controlled trial.

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Abstract

Background: Chronic non-specific low back pain (CNSLBP) is a common musculoskeletal condition associated with pain, functional disability, reduced mobility, and psychosocial impairments. Manual therapy combined with exercise is widely used in physiotherapy, but comparative evidence between Myofascial Release Technique (MFR) and Muscle Energy Technique (MET) remains limited.

Objective: To compare the effects of MFR plus exercise versus MET plus exercise on pain intensity, functional disability, fear-avoidance beliefs, and lumbar mobility in individuals with CNSLBP.

Methods: A prospective, assessor-blinded randomized controlled trial was conducted on 60 participants with CNSLBP recruited from private physiotherapy clinics in Peshawar, Pakistan. Participants were randomly allocated into two groups: MFR with exercise (n=30) and MET with exercise (n=30). Both interventions were administered three times weekly for six weeks. Outcome measures included Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), Fear-Avoidance Beliefs Questionnaire (FABQ), and Modified Schober Test. Assessments were taken at baseline, Week 3, and Week 6. Data were analyzed using repeated measures ANOVA with $p < 0.05$ considered significant.

Results: Both groups showed significant improvements in all outcomes over time ($p < 0.001$). However, the MFR plus exercise group demonstrated significantly greater improvements than the MET group. At Week 6, the MFR group showed lower pain scores (2.14 ± 0.83 vs 3.18 ± 0.91), reduced disability (16.82 ± 5.41 vs 23.61 ± 6.08), lower fear-avoidance beliefs (20.43 ± 4.72 vs 27.14 ± 5.06), and improved lumbar mobility (6.82 ± 0.74 cm vs 5.94 ± 0.68 cm), with statistically significant differences ($p < 0.001$).

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Conclusion: Both interventions were effective in managing CNSLBP; however, MFR combined with exercise was superior to MET combined with exercise in improving pain, disability, psychosocial factors, and lumbar mobility. These findings support incorporating myofascial techniques into exercise-based rehabilitation for CNSLBP.

INTRODUCTION

Chronic non-specific low back pain (CNSLBP) is one of the most disabling, common and costly musculoskeletal conditions in the world and remains a significant problem for healthcare systems, clinicians and rehabilitation researchers. It is usually described as pain and distress felt between the inferior margin of the ribs and the gluteal folds, which has not been diagnosed as infection, malignancy, fracture, inflammatory disease or radiculopathy and lasts more than 12 weeks. Low back pain (LBP) is now known as the number one cause of years lived with disability worldwide and a problem in all age groups, especially in working-age adults. Chronic low back pain (LBP) prevalence and disability have been reported to be growing in all Global Burden of Disease studies; the significant socioeconomic burden of chronic LBP with regard to healthcare expenditure, absenteeism, decreased work productivity, and decreased quality of life has been consistently highlighted. Current epidemiological data suggest that almost 70-80% of adults suffer from low back pain at some point in their lives and that 10-20% develop chronic, persistent symptoms as a result of recurrent pain, psychological distress and functional impairment [1, 2].

Chronic non-specific LBP is a multifactorial problem where biomechanical, neuromuscular, psychosocial and neurophysiological factors interact in a complex manner. Chronic low back pain is redefined from a purely biomedical approach to a biopsychosocial approach due to recent advances in pain science, which view chronic back pain as a complex phenomenon that is influenced by physical impairments and psychological factors. Five factors have been suggested as being important for symptom chronicity: persistent nociceptive input, altered movement patterns, central sensitisation, muscular dysfunction, and fear-related behaviours [3]. In addition, people with

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CNSLBP often have impairments in lumbar stability, loss of spinal mobility, fascial restrictions, muscle imbalance, altered proprioception, and impaired neuromuscular coordination, which can continue to cause pain and disability [4].

The role of psychosocial factors in the severity of chronic low back pain and rehabilitation is an important aspect. Fear avoidance beliefs and pain catastrophising, anxiety, depression, and kinesiophobia have been identified as important predictors of chronic disability and inadequate functional outcomes. In the fear avoidance model, the fear of movement and physical activity may lead to their avoiding typical movement patterns because they believe this movement is painful or could cause them to re-injure themselves. This avoidance behaviour then causes the physical deconditioning, muscle weakness, loss of mobility, and maintenance of chronic pain [5]. Patients with chronic low back pain who suffer from fear avoidance beliefs are strongly linked to disability, delay to activity and poor treatment adherence. Modern rehabilitation techniques have, therefore, made a shift towards a more multidimensional approach that aims to address physical and psychosocial dysfunctions, rather than just alleviation of pain.

International clinical practice guidelines [6] strongly recommend exercise therapy for chronic non-specific low back pain, and it is the mainstay of conservative treatment. Therapeutic exercise interventions such as core stabilisation exercises, motor control training, flexibility exercises, stretching, strengthening, and lumbar stabilisation programmes have been shown to be effective at improving functional performance, increasing spinal stability, decreasing pain intensity, and increasing movement confidence. Exercise-based rehabilitation promotes improvement in postural control, muscle endurance and functional independence and facilitates neuromuscular re-education [7]. However, there are benefits of exercise therapy, but many people still report that they experience pain, reduced movement and/or functional limitations after exercise therapy, which suggests that adjunctive manual techniques may have an impact on rehabilitation outcomes.

Manual therapy interventions are gaining increasing interest in musculoskeletal rehabilitation due to their ability to reduce pain, increase tissue extensibility, correct movement patterns and optimise

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neuromuscular function. Of these interventions, the Myofascial Release Technique (MFR) and Muscle Energy Technique (MET) are commonly used in the physiotherapy setting with chronic low back pain. Both methods seek to optimise the function of the musculoskeletal system and decrease pain but have very different theories, structural principles, and therapeutic uses.

Myofascial release technique is a soft tissue mobilisation technique in which manual pressure is applied and fascia is stretched to mobilise fascia and decrease restrictions in the myofascial system. Fascia is now known to be a highly innervated and important system for force transmission, proprioception, movement coordination and modulation of nociception. Chronic musculoskeletal pain syndromes such as chronic low back pain have been associated with alterations of fascial mobility and stiffness [8]. Impaired biomechanical loading, impaired circulation, development of tissue adhesions, decreased mobility, and sensitisation of nociceptive pathways may all be related to fascial dysfunction. The proposed mechanism of action of MFR is to restore the extensibility and mobility of the fascia, stimulate mechanoreceptors, modulate the autonomic nervous system and enhance local circulation through viscoelastic deformation. Lastly, myofascial interventions can help to desensitise the central pain processing mechanisms involved in chronic pain syndromes and also diminish sympathetic overactivity [9].

There have been several clinical trials and systematic reviews of the efficacy of MFR in the treatment of chronic low back pain. A systematic review and meta-analysis by Wu et al. found that myofascial release was effective for reducing pain intensity and improving physical function in individuals with chronic low back pain, but results for other outcomes, such as quality of life and trunk mobility, were inconclusive [10]. Likewise, Ożóg et al. showed that single myofascial release techniques can be beneficial for decreasing pain and disability for adults with chronic LBP, but that future research is needed to establish standardised protocols and randomised controlled trials of higher quality [11]. While the potential for effectiveness has been demonstrated, there are significant differences in treatment length, intervention procedures, and measures of outcome, making the findings less generalisable.

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Manually, the Muscle Energy Technique is an active method which requires the patient to voluntarily contract the muscle against a therapist's resistance. The primary focus of MET is muscular tightness, loss of motion, joint dysfunction and neuromuscular control. The therapeutic rationale for MET is related to the neurophysiological mechanisms that are used, including post-isometric relaxation, reciprocal inhibition, Golgi tendon organ activation, and normalising muscle spindle activity [12]. In this way, MET can help to lower muscle tension, increase flexibility, restore joint mobility and increase efficiency of movement. Due to its passive, noninvasive and patient-centred approach, MET has grown in popularity for physiotherapy and osteopathic treatment of spinal conditions.

Previous studies have shown that MET is effective in improving pain and disability in chronic low back pain patients. Al Matif and colleagues carried out a recent systematic review of 17 randomised controlled trials that showed significant benefits of MET in chronic low back pain populations in terms of pain intensity, lumbar range of motion and functional disability [13]. In a similar study, Santos et al. reported beneficial outcomes for MET on pain and disability in patients with non-specific low back pain, but results were not conclusive due to methodological problems and heterogeneity. [14] Previous Cochrane reviews also recognised the possible benefits of MET but noted that current studies were generally small in size, had a high risk of bias and were poorly designed [15].

While both MFR and MET seem to be beneficial for chronic low back pain, the relative efficacy of these interventions is not sufficiently investigated in the context of standardised exercise intervention. Several important limitations have been shown in the existing literature. First, many of the previous studies had small sample sizes, which meant that the power of the study was limited and the external validity was reduced. Secondly, many trials did not implement a suitable randomisation strategy or allocation concealment, assessor blinding, or long-term follow-up evaluation. Third, previous studies have tended to assess outcomes primarily with measures of pain intensity and disability, rather than the important psychosocial and functional outcomes (e.g., fear-

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avoidance beliefs and lumbar mobility). Fourth, exercise interventions are frequently not well standardised with manual therapy techniques, which makes it difficult to assess the real effect of manual therapy interventions alone or in combination with exercise [10–15].

Multidimensional assessment of outcomes is now becoming a focus in contemporary rehabilitation research in chronic pain care. Reducing pain is no longer enough to measure the effectiveness of treatment. Rather, relevant rehabilitation outcomes should be focused on an increase in physical function, psychosocial status, movement confidence and spinal mobility. It is important to recognise that fear avoidance beliefs are a direct determinant of activity participation, adherence, and prognosis in CLBP individuals [5]. Likewise, the mobility of the lumbar region is one of the important factors that tells about the flexibility of the spine, its recovery and its functions. Assessment of interventions targeting both pain, disability, fear avoidance and lumbar mobility might, therefore, offer a more comprehensive understanding of the therapeutic efficacy.

As both the myofascial release technique and the muscle energy technique are widely used in the clinic, it is important to identify which technique is the most effective to be used with exercise therapy. Comparative efficacy may help inform clinicians of the most effective treatments and rehabilitation and help to create personalised management plans for people with chronic non-specific low back pain. The objective of the present RTC is therefore to evaluate the efficacy of MFT and MMT when combined with exercise compared to MFT alone in reducing pain intensity and disability, reducing fear avoidance beliefs, and increasing the mobility of the lumbar spine in patients suffering from chronic non-specific LBP. This study aims to provide high-quality evidence on the comparative effectiveness of these widely used physiotherapeutic interventions by using a rigorous randomised controlled design and multidimensional outcome assessment while addressing gaps in the literature.

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Materials and Methods

Study Design

This study was designed to be a prospective, assessor-blinded, parallel-group randomised controlled trial. It was a prospective, assessor-blinded, parallel-group randomised controlled trial (RCT) that compared the effectiveness of Myofascial Release Technique (MFR) with exercise versus Muscle Energy Technique (MET) with exercise in people with chronic non-specific low back pain (CNSLBP). It has been designed and reported based on the Consolidated Standards of Reporting Trials (CONSORT) guidelines for randomised controlled trials, which provide a methodologically rigorous and transparent approach to the study [15].

Study Setting

This study was carried out in private physiotherapy and rehabilitation clinics of Peshawar, Pakistan, such as Yaseen Rehab Clinic, Physio Square and Habib Physiotherapy Complex. These clinics offer ambulatory musculoskeletal rehabilitation and have a large proportion of long-term (chronic) low back pain patients.

Study Duration

The study lasted 6 months from 1st January 2026 to 1st June 2026. All the recruitment of participants, administration of the intervention, assessment of the intervention, and data collection were done within the study period.

Participants

Target Population

The target population consisted of adult male and female patients who were diagnosed with chronic non-specific low back pain attending outpatient physiotherapy clinics in Peshawar.

Inclusion Criteria

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Participants fulfilling the following criteria were included in the study:

- Age between 18 and 50 years
- Presence of chronic non-specific low back pain persisting for more than 12 weeks
- Pain localized between the 12th rib and gluteal folds with or without referred pain
- Numeric Pain Rating Scale (NPRS) score between 3 and 7
- Ability to understand and follow verbal instructions
- Willingness to participate and provide written informed consent

Exclusion Criteria

Participants were excluded if they had:

- Specific spinal pathology including fracture, tumor, infection, inflammatory disease, or malignancy
- Lumbar radiculopathy or neurological deficits
- Previous spinal surgery
- Pregnancy
- Severe osteoporosis
- Spondylolisthesis grade III or IV
- Recent spinal trauma
- Congenital spinal deformities
- Systemic neurological disorders
- Current participation in another rehabilitation program
- Contraindications to manual therapy or exercise

Sample Size Calculation

The sample size was determined with the software G*Power version 3.1, based on repeated measures analysis of variance (ANOVA). The calculation was done based on an effect size that was derived

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from previous studies that examined manual therapy interventions in chronic low back pain populations [16, 17]. An effect size of 0.30 was used, with alpha set at 0.05, a statistical power of 80%, and two intervention groups with repeated measurements; the minimum sample size was determined to be 52 participants. A total sample of 60 participants was recruited, with 30 participants in each group, to compensate for possible attrition.

Sampling Technique

The eligible participants were recruited from the selected physiotherapy clinics using the non-probability consecutive sampling technique. Patients who met the inclusion/exclusion criteria were invited to participate in the study.

Randomization and Allocation Concealment

Following baseline assessment, participants were randomly assigned to either exercise group, MFR (Group A) or exercise group, MET (Group B). Randomisation was accomplished by use of a random allocation sequence generated by computer by another investigator not involved in the assessment or treatment of the subjects.

The allocation concealment was achieved by sequentially numbered opaque sealed envelopes. The group assignment was presented in each envelope and only opened after the enrolment and baseline assessment of the participants.

Blinding

Because of the characteristics of manual therapy interventions, it was not feasible to blind therapists and participants. But the outcome assessor and statistical analyst were not aware of group allocation during the study to avoid assessment and analytical bias.

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Ethical Considerations

Before data collection, ethical approval was given by the Institutional Research Ethics Committee. The study was also approved by the administrations of the clinics. Prior to enrolment, all participants were informed of the purpose, procedures, potential benefits and risks of the study. All participants gave written informed consent before participating. The confidentiality and anonymity of information from participants was carefully guarded throughout the study. Volunteers were told that they could leave the study at any time with no consequences.

Outcome Measures

A blinded assessor completed outcome assessments at baseline (Week 0), mid-intervention (Week 3) and post-intervention (Week 6).

Primary Outcome MeasurePain Intensity

There was a Numeric Pain Rating Scale (NPRS) with 11 points ranging from 0 ("no pain") to 10 ("worst imaginable pain") used to determine the intensity of pain. NPRS is a valid and reliable measure widely used in chronic LBP patients [18].

Secondary Outcome Measures

Functional Disability

The Oswestry Disability Index (ODI) was used to measure functional disability. An ODI is a questionnaire designed to assess any limitations in activities of daily living associated with low back pain that are related to a disease. The maximum score is 100, and higher scores mean more disability [19].

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Fear Avoidance Beliefs

Beliefs around fear avoidance were assessed with the Fear-Avoidance Beliefs Questionnaire (FABQ), a questionnaire that assesses beliefs about the impact of physical activity and work on pain. The higher the scores, the more fear avoidance behaviour is shown [20].

Lumbar Mobility

The modified Schober test, used to measure the range of motion at the lumbar level, was used to assess mobility. The test has been found to be a valid and reliable test in patients with a low back pain episode [21].

Intervention Protocol

All individuals in both groups were treated three times a week for six consecutive weeks. The duration of each treatment was about 40 – 45 minutes.

Group A: Myofascial Release Technique Combined with Exercise

The participants were divided into two groups: Group A, who got MRT, and Group B, who got the standard exercise programme.

Myofascial Release Technique

The myofascial release technique was performed with sustained manual pressure and fascial stretching on the thoracolumbar fascia, lumbar paraspinal muscles, quadratus lumborum and hamstring fascia. The duration of each fascial restriction was around 90 – 120 seconds until they reached tissue release.

The intervention included:

- Longitudinal fascial stretching
- Cross-hand fascial release

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- Sustained pressure release
- Thoracolumbar fascial mobilization

Overall, time spent on manual therapy was about 15-20 minutes per session.

Exercise Program

The standardized exercise program included:

- Core stabilization exercises
- Pelvic tilting exercises
- Lumbar flexibility exercises
- Hamstring stretching
- Cat-camel exercises
- Bridging exercises
- Transverse abdominis activation exercises

The exercises were performed in 2-3 sets of 10 repetitions, progressing as tolerated by participants.

Group B: Muscle Energy Technique Combined with Exercise

The standardized exercise program was given to all participants, with the addition of the Muscle Energy Technique to the group assigned to Group B.

Muscle Energy Technique

The muscles of the lumbar paraspinal muscles, quadratus lumborum, iliopsoas, and hamstring muscles were treated with M.E.T. Voluntary isometric contractions were made against the therapist's resistance, then followed by relaxation and passive stretch.

The intervention included:

- Post-isometric relaxation techniques
- Reciprocal inhibition techniques

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- Lumbar flexor and extensor muscle MET
- Hamstring and hip flexor MET

Each contraction was maintained for 7–10 seconds followed by relaxation and stretching for 20–30 seconds. Three to five repetitions were performed for each muscle group.

The total duration of manual therapy application was approximately 15–20 minutes per session.

Exercise Program

The standardised exercise protocol was given to Group B in order to ensure uniformity of treatment.

Data Collection Procedure

A total of 117 patients with chronic non-specific low back pain were screened, and eligible patients were selected from the chosen clinics based on the pre-canned inclusion and exclusion criteria. People who met the criteria were informed and gave written consent to participate and were screened. Participants who agreed to participate and signed a written informed consent underwent baseline assessment. Participants were then randomly assigned to the two intervention groups.

The outcome measures were completed at baseline, Week 3 and Week 6. The adherence to treatment and any adverse events during the intervention period were recorded during the study.

Statistical Analysis

IBM SPSS Statistics version 26.0 was used for data analysis. Demographic and baseline characteristics were expressed in terms of descriptive statistics: mean, SD, frequencies, and percentages.

The normality of the data distribution was checked with the Shapiro–Wilk test. Baseline characteristics were compared between the groups by using independent sample t-tests and chi-square tests.

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Within-group and between-group differences over time were tested for pain intensity, disability, fear avoidance beliefs, and lumbar mobility using two-way repeated measures ANOVA. The interaction effects were also examined between group and time. Partial eta squared and Cohen's d values were used to determine effect sizes. A p-value of less than 0.05 and a 95% confidence interval were used to determine statistical significance.

To deal with the participants who dropped out and missing data, the intention-to-treat analysis approach was followed.

Results

Participant Flow

In the recruitment period 78 people were screened for eligibility. Of these, 12 did not meet the inclusion criteria, and 6 refused to participate. Thus, 60 participants were enrolled and randomly divided into two intervention groups: 30 participants in the Myofascial Release Technique and exercise intervention (MFR group) and 30 participants in the Muscle Energy Technique and exercise intervention (MET group).

There were personal reasons and missed attendance for 2 participants in the MFR group and 1 in the MET group during the intervention period. Thus, 57 participants were analysed post intervention. The analysis was conducted using an intention-to-treat approach to include missing data and participant attrition.

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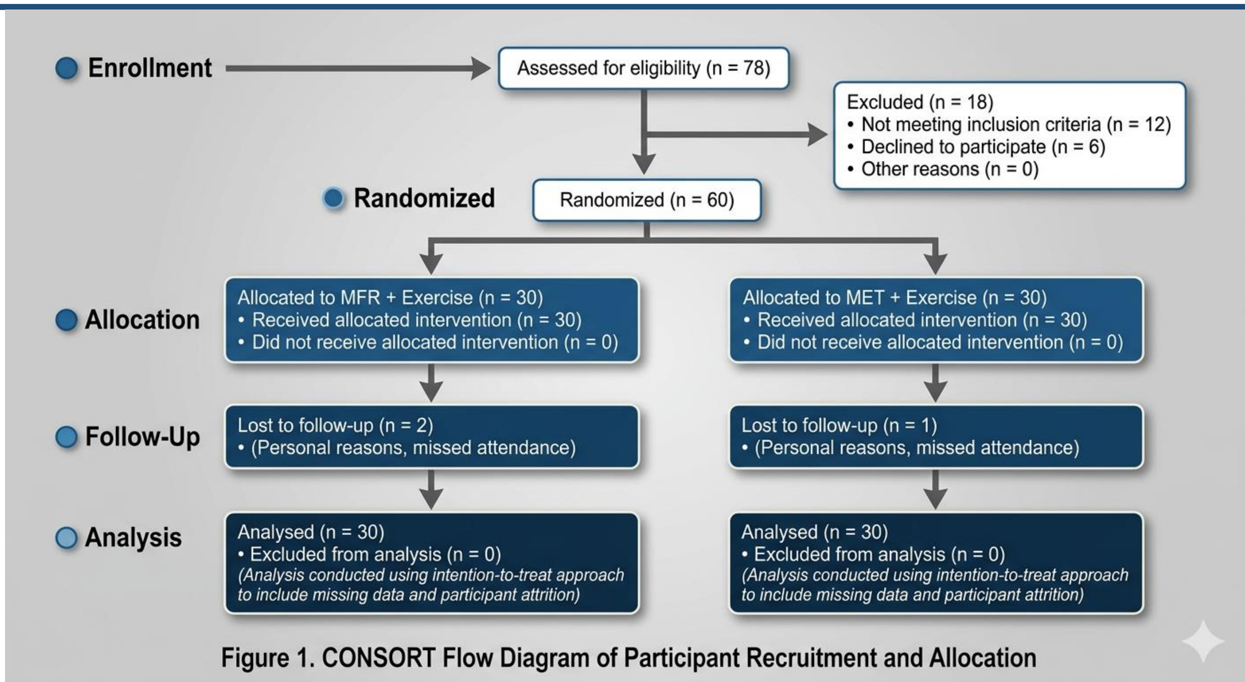

Figure 1. CONSORT Flow Diagram of Participant Recruitment and Allocation

Baseline Characteristics

The demographic and clinical features of the participants at baseline are shown in Table 1. At baseline, no significant differences were found between the two groups ($p > 0.05$) so as to ensure successful randomisation and baseline comparability.

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Table 1. Baseline Demographic and Clinical Characteristics of Participants

Variable	MFR + Exercise Group (n = 30) Mean ± SD	MET + Exercise Group (n = 30) Mean ± SD	p-value
Age (years)	33.87 ± 7.12	34.53 ± 6.84	0.712
Height (cm)	168.34 ± 8.22	167.81 ± 7.96	0.801
Weight (kg)	71.24 ± 9.33	72.11 ± 8.94	0.714
BMI (kg/m²)	25.18 ± 2.84	25.61 ± 2.65	0.548
Duration of Symptoms (months)	9.84 ± 3.42	10.12 ± 3.67	0.763
Baseline NPRS	6.63 ± 0.76	6.57 ± 0.82	0.772
Baseline ODI (%)	42.31 ± 7.94	41.76 ± 8.12	0.794
Baseline FABQ	42.52 ± 5.48	41.89 ± 5.74	0.668
Baseline Modified Schober Test (cm)	4.18 ± 0.62	4.21 ± 0.58	0.842

Independent sample t-test; significance level set at $p < 0.05$.

Pain Intensity

There was a statistically significant decrease in pain intensity over time in both intervention groups ($p < 0.001$; repeated measures ANOVA). A large interaction effect between significant group and time was also found ($p < 0.001$), suggesting that the differential change was apparent during the intervention period.

The MFR group showed significantly more reduction in pain intensity at Weeks 3 and 6 than the MET group. The mean NPRS score in the MFR group decreased from 6.63 ± 0.76 at baseline to 2.14 ± 0.83 at Week 6, whereas the MET group showed a reduction from 6.57 ± 0.82 to 3.18 ± 0.91.

Table 2. Comparison of Pain Intensity (NPRS) Between Groups

Time Point	MFR + Exercise Mean ± SD	MET + Exercise Mean ± SD	p-value

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Baseline	6.63 ± 0.76	6.57 ± 0.82	0.772
Week 3	4.12 ± 0.91	4.98 ± 0.88	0.001
Week 6	2.14 ± 0.83	3.18 ± 0.91	<0.001

Repeated measures ANOVA revealed significant within-group improvement ($p < 0.001$) and significant between-group difference favoring the MFR group ($p < 0.001$).

Functional Disability

After intervention both groups showed a significant improvement in functional disability ($p < 0.001$). Participants who received MFR in addition to exercise, however, had significantly lower scores on Oswestry Disability Index than did participants who received MET in addition to exercise.

The mean ODI score in the MFR group improved from 42.31 ± 7.94 at baseline to 16.82 ± 5.41 at Week 6, whereas the MET group improved from 41.76 ± 8.12 to 23.61 ± 6.08.

Table 3. Comparison of Functional Disability (ODI) Between Groups

Time Point	MFR + Exercise Mean ± SD	MET + Exercise Mean ± SD	p-value
Baseline	42.31 ± 7.94	41.76 ± 8.12	0.794
Week 3	28.24 ± 6.72	32.81 ± 6.95	0.013
Week 6	16.82 ± 5.41	23.61 ± 6.08	<0.001

Repeated measures ANOVA revealed significant time effect ($p < 0.001$) and significant group × time interaction effect ($p < 0.001$).

Fear Avoidance Beliefs

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Results of the analysis of FABQ scores indicated highly significant decreases in fear avoidance belief for both groups across the 12 months of the intervention ($p < 0.001$). However, the MFR group had significantly greater decreases in fear avoidance beliefs than the MET group.

The mean FABQ score decreased from 42.52 ± 5.48 to 20.43 ± 4.72 in the MFR group, while the MET group improved from 41.89 ± 5.74 to 27.14 ± 5.06 at Week 6.

Table 4. Comparison of Fear Avoidance Beliefs (FABQ) Between Groups

Time Point	MFR + Exercise Mean ± SD	MET + Exercise Mean ± SD	p-value
Baseline	42.52 ± 5.48	41.89 ± 5.74	0.668
Week 3	31.18 ± 5.11	35.06 ± 5.27	0.006
Week 6	20.43 ± 4.72	27.14 ± 5.06	<0.001

Repeated measures ANOVA demonstrated significant within-group improvement ($p < 0.001$) and significant interaction effect favoring the MFR group ($p < 0.001$).

Lumbar Mobility

There was significant improvement in both groups in lumbar mobility based on the modified Schober test ($p < 0.001$) after intervention. The MFR group, however, with exercise showed a significant improvement compared to the MET with-exercise group.

The lumbar mobility score of the MFR group at baseline was 4.18 ± 0.62 cm, and at Week 6 it was 6.82 ± 0.74 cm. In comparison, the MET group improved from 4.21 ± 0.58 cm to 5.94 ± 0.68 cm.

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Table 5. Comparison of Lumbar Mobility Between Groups

Time Point	MFR + Exercise Mean ± SD	MET + Exercise Mean ± SD	p-value
Baseline	4.18 ± 0.62	4.21 ± 0.58	0.842
Week 3	5.42 ± 0.66	4.98 ± 0.63	0.011
Week 6	6.82 ± 0.74	5.94 ± 0.68	<0.001

Repeated measures ANOVA demonstrated significant within-group improvement ($p < 0.001$) and significant between-group differences favoring the MFR group ($p < 0.001$).

Effect Size Analysis

All primary and secondary outcome measures showed large effect sizes. The MFR group showed greater effect sizes than the MET group for all outcomes related to pain intensity, disability, fear avoidance beliefs, and lumbar mobility.

Table 6. Effect Size Analysis for Outcome Measures

Outcome Variable	Partial Eta Squared (η^2)	Cohen's d	Interpretation
Pain Intensity (NPRS)	0.41	1.21	Large
Functional Disability (ODI)	0.38	1.08	Large
Fear Avoidance Beliefs (FABQ)	0.35	0.97	Large
Lumbar Mobility	0.33	0.91	Large

Adverse Events and Treatment Compliance

In both groups, no serious adverse events were reported during the intervention period. Three MFR and two MET participants reported mild transient soreness following manual therapy interventions, but symptoms were self-limited in 24 hours.

No one missed treatment in either group, and attendance was greater than 90% during the intervention period.

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Discussion

The present randomised controlled trial (RCT) compared the effects of two manual therapy techniques (Myofascial Release Technique [MFR] versus Muscle Energy Technique [MET]) combined with exercise on pain intensity, functional disability, fear avoidance beliefs, and lumbar mobility in chronic non-specific low back pain (CNSLBP) patients. The findings showed that, after six weeks of intervention, both interventions statistically and clinically significantly increased all measured outcomes. The participants receiving MFR in addition to exercise, however, showed significantly greater gains in terms of pain reduction, disability, fear avoidance beliefs and lumbar mobility than the participants receiving MET in addition to exercise. These results indicate that both treatments have a positive effect on the conservative management of CNSLBP; however, MFR is more effective when incorporated into an exercise rehabilitation programme.

The results of the present study confirm the modern concept of chronic non-specific LBP as a multidimensional disease, characterised by biomechanical dysfunction, neuromuscular defects, fascial restriction, altered motor control and psychosocial maladaptation. The marked improvement seen in both treatment groups confirms that multimodal physiotherapy treatment is effective in the treatment of chronic low back pain. Despite this, the better results verified with the use of MFR show that a fascial dysfunction may be a more significant factor in the chronic persistence of low back pain than is conventionally recognised in traditional musculoskeletal rehabilitation approaches.

One of the more striking results of the present study was the reduction of pain. Both groups experienced statistically significant decreases in Numeric Pain Rating Scale (NPRS) scores after intervention, but the decrease was significantly greater for the MFR group. Importantly, the amount of pain reduction that was seen was greater than the minimal clinically important difference (MCID) reported for the general chronic low back pain population, implying a clinically meaningful benefit as well as a statistical benefit. The results of these studies have been supported by other systematic reviews and meta-analyses which have shown positive outcomes of myofascial interventions for chronic musculoskeletal pain conditions. Wu et al. have found that MFR is effective in reducing

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pain intensity and enhancing physical function in chronic low back pain populations but reported that there were some differences in interventions, making it difficult to draw definitive conclusions on the dosage and application parameters for optimal treatment [22]. Likewise, Arguisuelas et al. determined that manual myofascial techniques helped achieve clinically significant improvements in pain perception and functional recovery in individuals with chronic spinal pain disorders [23].

These superior analgesic effects seen in the MFR group could be attributed to several interrelated biomechanical and neurophysiological mechanisms. Research in the modern times is increasingly acknowledging that fascia is an active, rather than passive, sensory organ. Fascia is rich in mechanoreceptors, free nerve endings, Ruffini corpuscles, Pacinian corpuscles and interstitial receptors that can impact nociception, proprioception, autonomic regulation and movement coordination [24]. Impaired tissue glide, abnormal force transmission, reduced circulation and sustained nociceptive activation are potential factors that can be the result of chronic fascial restrictions and densification. Thus, either peripheral or central sensitisation mechanisms may sustain pain when there is fascial dysfunction.

The Myofascial Release Technique may have been more effective in reducing pain, as it directly addressed the fascial abnormalities. Fascial stretching and manual pressure can normalise viscoelasticity of connective tissue, rehydrate tissue, break down adhesion and restore normal sliding mechanics. Also, stimulation of mechanoreceptors in MFR can gate afferent nociceptive input via spinal gating mechanisms and descending inhibitory pathways. During prolonged fascial manipulation, stimulation of Ruffini endings could lead to a decrease in sympathetic nervous system activity, lower muscle tone, and increased parasympathetic nervous system activity, which would help to achieve relaxation and pain relief [25]. In addition, MFR could modulate inflammatory mediators and biochemical processes that are part of chronic pain states. There is growing evidence that fascial manipulation can help to lower concentrations of pro-inflammatory cytokines and promote local microcirculation that can aid in the recovery of tissue and decrease nociceptive sensitisation [26].

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Another very important one is the link between chronic pain and central sensitisation. Restricted fascial tissues can cause persistent nociceptive input that can lead to hyperexcitability in the central nervous system, which can exacerbate pain perception without much structural damage. Peripheral nociceptive drive reduction and restoration of normal sensory input can help to reduce central sensitisation and therefore may benefit from myofascial interventions [27]. This mechanism could account for the significant decrease in pain that was seen in the MFR group and further suggests the importance of fascial dysfunction in the pathophysiology of chronic low back pain.

Participants who received MET plus exercise showed some significant pain reduction as well, but not as great. MET works primarily on the basis of neurophysiological concepts, such as post-isometric relaxation, reciprocal inhibition, Golgi tendon organ activation and normalisation of muscle spindle activity [28]. These mechanisms have a good effect on reducing muscular hypertonicity and increasing flexibility, but MET has relatively less effect on the diffuse restrictions in the fascia and the dysfunction of the connective tissues. The results of the present study indicate that interventions specifically aimed at fascial structures might be more effective for persistent pain in chronic low back pain.

Finally, functional disability measured by the Oswestry Disability Index (ODI) also showed significant improvement in both groups, but better improvement in the MFR plus exercise group. There is often significant dysfunction in the activities of daily living, employment and social life accompanying chronic low back pain. In chronic pain populations, disability can also be affected by movement avoidance, changes in biomechanics, psychological distress and decreased physical condition, as well as pain intensity [29]. Thus, interventions that can tackle multiple aspects of dysfunction are more likely to yield significant disability improvements.

The improvement in disability reduction in the MFR group might be due to increased efficiency of the movement and normalisation of the biomechanics functions. Injuries to the fascia can disrupt the normal patterns of movement and lead to compensatory movement patterns, resulting in greater mechanical stress against other structures. MFR can help to increase fascial mobility and decrease

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soft tissue stiffness, which may lead to better force transmission and functional movement patterns [30]. In addition, lower levels of pain could have helped participants to more actively participate in rehabilitation activities and activities of daily living, which led to better functional independence.

Interestingly, the present study results showed significant improvement in fear avoidance beliefs in both groups of intervention, showing more significant improvement in the MFR group. This is an important finding, as fear avoidance beliefs are among the most robust social-demographic risk factors for chronic disability and persistent LBP in LBP populations. The fear avoidance model suggested by Vlaeyen and Linton (2003) states that people who catastrophise pain can become excessively fearful of movement, leading to avoidance of activities and progressive deconditioning, thus maintaining chronic pain cycles [31]. This means fear avoidance beliefs are seen as a key target for rehabilitation in contemporary biopsychosocial approaches.

This effect on fear avoidance might be due to a combination of physical symptom improvement and psychological adaptation, as seen in the MFR group. This may have led to a significant decrease in pain and an improvement in comfort with the movement, which would be associated with a decrease in fear of physical activity and an increase in movement confidence. Furthermore, hands-on techniques of myofascial interventions might give reassurances, relax and reassure, establish a therapeutic alliance and increase body awareness, which could have beneficial psychological effects on the experience of pain [32]. Recently, there has been some evidence that manual therapy interventions have context-dependent and neurocognitive effects, such as modulation of pain intensity, reduction of anxiety, and improvement of self-efficacy, in addition to mechanical effects [33]. Thus, the results of the present study reinforce the increasing awareness that both physical and psychosocial factors play a role in chronic LBP and that a rehabilitation programme for chronic LBP must address both factors simultaneously to effectively reduce disability.

The Modified Schober Test for lumbar mobility also significantly improved in both groups after intervention. Yet, the participants who were treated with MFR showed much higher improvement than the MET-treated participants. Chronic LBP is often associated with restricted lumbar mobility,

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which can be caused by muscular tightness, fascial adhesions, protective muscle guarding and altered motor control strategies [34]. The restoration of lumbar mobility is clinically significant, as mobility of the spine is related to functional movement capacity and physical performance.

The effects of MFR on improving lumbar mobility observed may be due to direct effects on the extensibility of the connective tissue and fascial glide. The thoracolumbar fascia is an important component of the spine's biomechanics and a pathway for moving loads from the spine to the lower body. This fascial chain can have a significant impact on the efficiency of movement and on stiffness at the lumbar level [35]. Sustained fascial stretching during MFR may have helped to restore tissue compliance and enhanced mechanical sliding between fascial layers, allowing for more LBROM. MET, however, while being effective in increasing the flexibility of muscles, seems to have a more limited effect on the muscles and not so much on more widespread fascial restrictions.

Another strength of the present study is that it includes exercise therapy in both intervention programmes. Exercise therapy is the main pillar in the management of chronic low back pain owing to the fact that it is efficient in promoting spinal stability, muscle endurance, motor skills, and functional movement [6]. But exercise alone might fail in overcoming issues related to soft tissue restriction, sensitisation of pain and psychosocial factors hindering individuals from engaging in physical exercises. Integrating manual therapy with exercises might improve rehabilitation results through alleviation of pain and increasing exercise tolerance.

First, the randomised controlled design of the experiment enhanced validity and minimised selection bias. Second, assessor blinding minimised the chances for measurement bias. Third, multiple outcomes, such as pain, disability, fear avoidance beliefs, and lumbar movement, were used, allowing for a biopsychosocial assessment of rehabilitation success. Fourth, standardisation of interventions ensured consistent treatment and reliability. Fifth, the setting of the study in private rehabilitation clinics increased its ecological validity and helped to replicate it in real conditions of practice.

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On the other hand, there are several limitations that need to be highlighted. Intervention lasted six weeks, and no further follow-up assessments were performed. Thus, sustainability of the results remains unclear. Chronic low back pain is known to recur in a cyclic fashion, so only long-term follow-up can provide insight into the durability of the achieved improvements. Also, it was impossible to use therapist and patient blinding, thus leaving an open place for both performance and expectation biases. However, assessor blinding was maintained, which still does not rule out placebo and contextual effects related to manual therapy procedures.

The lack of objective biomechanical and neurophysiological measures is another issue worth mentioning. Electromyography, muscle activation, indices of central sensitisation, and imaging of fascia were not examined in the study. The inclusion of objective biomarkers might have helped to understand how these treatments work and what changes take place during their administration. Furthermore, important psychosocial factors, such as depression, anxiety, pain catastrophising, and self-efficacy, were not measured since they have a significant impact on the efficacy of chronic low back pain treatment.

It will be beneficial to conduct future investigations aimed at evaluating the efficacy of manual therapy techniques from the perspective of long-term comparative research. Multi-centred randomised controlled trials that would include a prolonged follow-up period are required to provide additional proof regarding the superiority of myofascial therapies. Moreover, future investigations can consider the issue from a mechanistic perspective, thus examining the physiological characteristics of fasciae, pain modulation processes, and neuroimmune responses to various types of manipulation. Comparative studies with other types of interventions, such as cognitive functional therapy and pain neuroscience education, should also be conducted to create more personalised treatment programmes.

In general, the results of the current research clearly indicate that both Myofascial Release Technique along with physical exercise and Muscle Energy Technique along with physical exercise are highly effective tools in the rehabilitation of chronic nonspecific low back pain patients. At the same time,

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the Myofascial Release Technique appears to be more efficient than Muscle Energy Technique according to such outcome measures as pain intensity, functional impairment, fear avoidance beliefs, and lumbar motion range. Thus, fascial dysfunction can be viewed as one of the key features of chronic low back pain pathogenesis and is likely to require the incorporation of myofascial treatment in physical exercises-based therapies.

Conclusion

The results from the randomised controlled study showed that both the Myofascial Release Technique along with exercise and the Muscle Energy Technique along with exercise were beneficial in alleviating pain intensity, improving functional disability, reducing fear-avoidance beliefs and increasing lumbar flexibility among patients with chronic non-specific low back pain. Nonetheless, subjects who received the Myofascial Release Technique along with exercise experienced better outcomes with respect to all of the above-mentioned factors as compared to those who received the Muscle Energy Technique along with exercise.

The success with regard to treatment with the myofascial release technique can be linked to the direct effect of this therapy on fascial mobilisation, tissue extensibility, nociceptive regulation and efficient movement. Additionally, the results confirm the increasing evidence about the role played by fascial dysfunction in the physiopathology of chronic low back pain. The combination of manual techniques with exercise therapy seems to yield clinical improvements through an approach addressing various aspects of chronic pain.

This research study demonstrates the significance of employing a multidimensional biopsychosocial approach in the treatment of patients suffering from chronic non-specific low back pain. From the results obtained, the use of the myofascial release technique in combination with exercise appears to be a superior non-surgical therapeutic option to the use of the muscle energy technique along with exercise in enhancing pain reduction, disability, fear avoidance beliefs, and lumbar flexibility among patients with chronic non-specific low back pain.

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Further large-scale multicenter trials are therefore suggested to validate these results.

Conflict of Interest

The authors declared no conflict of interest regarding the publication of this study.

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