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Original Research Article

Effect of supervised exercise therapy program on the pain, disability, lumbar spine mobility and back muscle endurance in chronic non-specific low-back pain patients: a quasi-experimental design

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ABSTRACT

Background: Chronic non-specific low back pain (CNSLBP) is a prevalent musculoskeletal disorder that leads to pain, functional limitation, and reduced spinal mobility. Exercise therapy is widely recommended; however, the effectiveness of supervised exercise interventions requires further evaluation. This study aimed to determine the effect of supervised exercise therapy on pain, disability, lumbar spine mobility, and back extensor muscle endurance in patients with CNSLBP.

Methods: A quasi-experimental study was conducted on participants diagnosed with chronic non-specific low back pain. All participants underwent a 12-week supervised exercise therapy program that consisted of motor control exercises, strengthening, and stretching exercises. Outcome measures included pain intensity using the visual analogue scale (VAS), disability using the Oswestry disability index (ODI), spinal mobility using Schober's flexion and extension tests, and back extensor endurance using the Sorenson test. Pre- and post-intervention values were statistically analyzed, with significance set at $p<0.05$.

Results: Significant reductions were found in mean pain scores (VAS: 56.73 to 31.22, $p<0.001$) and disability levels (ODI: 24.33 to 12.72, $p<0.001$). There were notable improvements in back extensor endurance (Sorenson test: 28.68 to 51.27 seconds, $p<0.001$) and lumbar spine mobility in both flexion (Schober's flexion: 4.79 to 6.0 cm, $p<0.001$) and extension (2.8 to 3.8 cm, $p<0.001$).

Conclusion: Twelve weeks of supervised exercise therapy produced significant improvements in pain reduction, functional ability, lumbar spine mobility, and back extensor endurance among individuals with chronic non-specific low back pain. These findings support the incorporation of supervised exercise programs as an effective therapeutic approach for managing CNSLBP.

Keywords: Non-specific chronic low back pain, Supervised exercise therapy, Oswestry disability index

INTRODUCTION

Chronic low back pain is categorized as "non-specific" in 85% to 95% of instances since it cannot be linked to a known particular condition.[1] Nonspecific low back pain (LBP)is characterized by heavy pain, worsening with exertion, especially in the afternoon, relieved with rest, absence of neurological and muscle contraction, and antalgic posture, associated with inactivity and poor posture.[2] According to reports, low back pain is responsible for over half of the 6.8% of disability-adjusted life years that are attributed to musculoskeletal illnesses.[3] Given that many patients with chronic low back pain have reduced trunk strength, flexibility, and endurance, it stands to reason that an exercise program that addresses these deficits will result in an improvement in symptoms.[4] However, the results are inconsistent and ambiguous in the systematic reviews because of the heterogeneity of exercises included (from general exercises, training programs, or Pilates method to core stability exercise), duration, intensity, and the range of outcome measures analysed.[5-7] The effectiveness of this therapy for persistent low back pain is evident, but there is little proof that any particular kind of exercise is noticeably superior to others. Recent years have seen the introduction of numerous clinical trials based on core exercises and lumbopelvic stabilization programs to treat chronic low back pain. The majority of these trials have found that exercise therapy is more effective than other therapies (such as spinal manipulation, staying active, no treatment, and other conservative treatment) in reducing pain, improving posttreatment disability, building muscle strength, and enhancing long-term function.[5,6,8,9]

Restoring and improving muscle strength and endurance, joint flexibility and mobility, balance, coordination, and muscle control, as well as restoring postural motions and movement patterns, are the primary objectives of exercise therapy. By lowering pain and impairment, this should hasten recovery and allow for a return to regular activities. In comparison to normal care, no treatment, and placebo, recent data indicates that exercise therapy (ET) likely decreases pain. It may also improve impairment when compared to other treatments for chronic LBP.[10] Supervised exercise therapy is a popular physical therapy technique. It is conducted under the supervision and guidance of physical therapist. In order to address physical pathology, pain symptoms, and physical limitations, it employs a pain-contingent and practice-centred approach.[11] Different workout forms have varying durations and delivery methods.[10] Nevertheless, no particular form of exercise was found to be better, and there are disagreements over the most effective dosage and delivery strategies.[12] In the treatment of CNLBP, recent, low-quality research suggests that the best forms of exercise therapy (ET) for lowering pain and disability, enhancing mental well-being, and building muscular strength are stabilization/motor control exercises, resistance exercises, and aerobic exercises.[13]

Physical therapists recommend exercise as the mainstay of treatment for low back pain; therefore, it's critical to identify the right kind of exercise to help manage this condition. In light of this body of evidence, the primary objective of this study was to compare the effects of supervised exercise therapy (SET) on the following outcomes: pain intensity, disability, range of motion, spinal extensor muscle endurance, at the time immediately following the intervention (4 weeks) and after the third month of follow-up.

METHODS

Study design

This study employs a quasi-experimental design, utilizing a pre and post-test approach, conducted over a period of 12 months from July 2024 to August 2025 after receiving permission from the Institute Ethics Committee for Research Compliance. The study was conducted in outpatient department of physiotherapy in urban area. All participants signed written informed consent prior to the start of the study. Our study included 50 subjects with chronic non-specific LBP for supervised exercise therapy group (ETG, n=50). Therapeutic exercises were given for 4 weeks (3 times/week) and then all patients were asked to perform a therapeutic exercise program at home for 12 weeks.

Participants

Inclusion criteria for the study were men and women between the ages of 18 and 65 who experienced daily nonspecific (with no identifiable aetiology) low back pain or almost daily for at least 12 weeks. Participants with baseline pain intensity of 20-74 mm points on a visual analog scale from 0 to 100. A score of 14% or more on the Oswestry disability index (ODI), independently mobile (with or without aids) to be capable of participating in a rehabilitation programme.

Exclusion criteria for the study were patients having primary pain area other than the lower back (from T12 to buttocks), leg pain as the primary problem (e.g., nerve root compression or disc prolapse with true radicular pain/radiculopathy, lateral recess or central spinal stenosis), lumbar spine, lower limb or abdominal surgery in previous 6 months, Having undergone pain-relieving procedures such as injection-based therapy (e.g., epidurals) and day care procedures (e.g., rhizotomy) in the last 3months, pregnancy, rheumatological/inflammatory disease (e.g., rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis, lupus erythematosus, Scheuermann's disease), progressive neurological disease (e.g., multiple sclerosis, Parkinson's disease, motor neuron disease), scoliosis and any other spinal deformity, inadequate English/Marathi to complete outcome measures, unstable cardiac conditions, red flag disorders like malignancy/ cancer, Acute trauma such as fracture in the last 6 months or infection, or spinal cord compression/cauda equina syndrome.

Intervention

Therapeutic exercises were conducted by the researcher under supervision. The TE program used in this study is a multimodal exercise program consisting of warm up followed by kinaesthetic awareness exercises, motor control exercises for the lumbar spine stretching muscle strengthening exercises, aerobic exercise and functional activities training.[14-18] Kinaesthetic awareness exercises were initiated in supine or hook-lying positions and progressed to sitting, standing, and quadruped positions, performed for three sets of ten repetitions.

Motor control exercises were administered in the supine position (levels 1–3) and prone position (levels 1–2) for two sets of ten repetitions to enhance segmental spinal stability. Trunk strengthening included slow curl-ups and sit-ups, graded active flexion and graded active extension exercises performed in supine lying and prone lying for three sets of ten repetitions each. Lateral trunk endurance was trained using oblique plank (side bridge) exercises in side-lying, performed for three sets of 30-second holds.

The bird-dog exercise was performed in the quadruped position for three sets of ten repetitions to facilitate coordinated trunk and limb muscle activation. Flexibility exercises included stretching of the piriformis and erector spinae muscles in supine and prone positions, held for three sets of 30 seconds. Bridging exercises were performed in the supine position for three sets of ten repetitions to strengthen the gluteal and lumbar extensor muscles.

Exercises will be demonstrated to the participants, and then the participants performed the exercises independently. The researcher corrected each participant individually as required to ensure correct technique and ensured that the participants a performing their exercises correctly.

After four weeks of therapeutic exercises program, patients were taught about home exercises and ergonomic instructions was given. They were instructed to do the exercises 3 times a week for 12 weeks. They were provided with exercise template sheets and ergonomic instruction template. They were asked to maintain a diary of the record sheet. Also, after every week reminder of intervention was given via telephonic communication. And at the end of 12 weeks post intervention outcome measure was noted.

Outcome measures

Pain was assessed using visual analogue scale (r=0.94).[19] Disability was assessed using Oswestry disability index. Questionnaire examines perceived level of disability in 10 everyday activities of daily living. Studies indicate that the English as well as the translated Marathi versions of the ODI are reliable and valid instruments for the measurement of disability among Indian patients with LBP problems.[20] Back extensor endurance measured using Biering Sorensen test. The test as described by Sorenson is "measuring how many seconds the subject is able to keep the unsupported upper body (from the upper border of the iliac crest) horizontal, while placed prone with the buttocks and legs fixed to the couch by three wide canvas straps and the arms folded across the chest.[21-24] Forward flexion and extension range measured using modified Schober's test. The MMST demonstrated moderate validity (r=0.67; 95% CI 0.44–0.84), excellent reliability (intra: ICC=0.95; 95% CI 0.89–0.97; inter: ICC=0.91; 95% CI 0.83–0.96) and a MMDC of 1 cm.[25]

Sample size calculation

The sample size for the study was calculated using the formula, where n represents the sample size per group, σ is the pooled standard deviation, Δ is the expected mean difference, $Z_{1-\alpha/2}$ corresponds to the level of significance, and $Z_{1-\beta}$ corresponds to the power of the study.

$$n = (2 \times (Z_1\text{-}\alpha/_2 + Z_1\text{-}\beta)^2 \times \sigma^2)/\Delta^2$$

In this study, the pooled standard deviation (σ) was taken as 2.5, and the expected mean difference (Δ) as 1.4.26 The value of $Z_{1-\alpha/2}$ was 1.96 for a 5% level of significance (two-tailed), and $Z_{1-\beta}$ was 0.84 corresponding to 80% power. Substituting these values into the formula yielded a minimum required sample size of 50 participants.

Statistical analysis

Statistical Analysis was performed using IBM statistical analysis for the social analysis (SPSS) statistic's 26.0 software. The normality of data was tested using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Since the majority of the variables did not follow a normal distribution ($p<0.05$ for most parameters), the non-parametric Friedman ANOVA test was applied for comparing repeated measures across baseline, 4th week, and 12th week.

RESULTS

For this experimental study, a total of 84 (n=84) patients with low back pain were screened for eligibility. In all, 50 patients (mean age±SD: 35.64±11.75; 58% female) who fulfilled all the inclusion criteria and agreed to participate were included in the supervised physical therapy exercise group (n=50). One patient was drop out due to personal reasons. No patients presented mental disorders or depression/anxiety. The study included a total of 50 participants, out of which 21 were males (42%) and 29 were females (58%). The study participants' ages ranged from 18 to 65 years, with a mean age of 35.64±11.75 years, indicating that most participants were young to middle-aged adults.

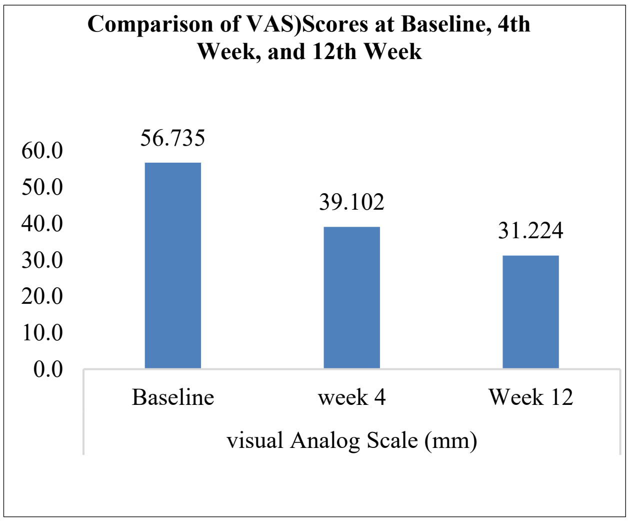

Figure 1: Comparison of visual analog scale scores for pain at baseline, 4th week, and 12th week.

Figure 1 shows that the mean VAS score for pain significantly decreased from 56.73±12.08 at baseline to 39.10±11.78 at 4 weeks and further to 31.22±11.68 at 12 weeks. The reduction was statistically significant (χ^2=86.49, $p<0.001$), indicating a marked improvement in pain levels over time.

Figure 2 shows that the mean ODI score decreased from 24.33±7.38 at baseline to 16.57±6.10 at 4 weeks and further to 12.72±6.07 at 12 weeks. This statistically significant reduction (χ^2=86.76, $p<0.001$) indicates a substantial improvement in functional disability over the study period.

Figure 3 demonstrates significant improvements in functional performance parameters over time. The Sorensen test scores increased from 28.68±22.97 seconds at baseline to 43.98±24.19 seconds at 4 weeks and 51.28±25.98 seconds at 12 weeks, while both Schober's flexion and extension measurements also showed progressive improvement. These changes were statistically significant ($p<0.001$), indicating enhanced lumbar muscle endurance and spinal mobility following intervention.

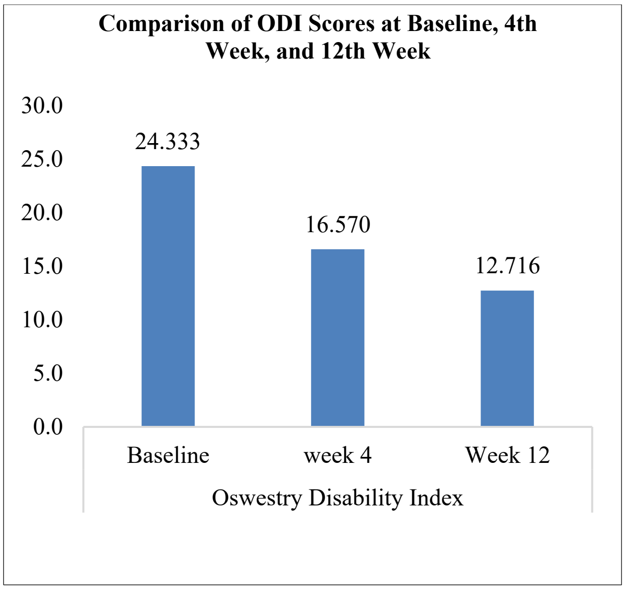

Figure 2: Comparison of Oswestry disability index scores for functional disability at baseline, 4th week, and 12th week.

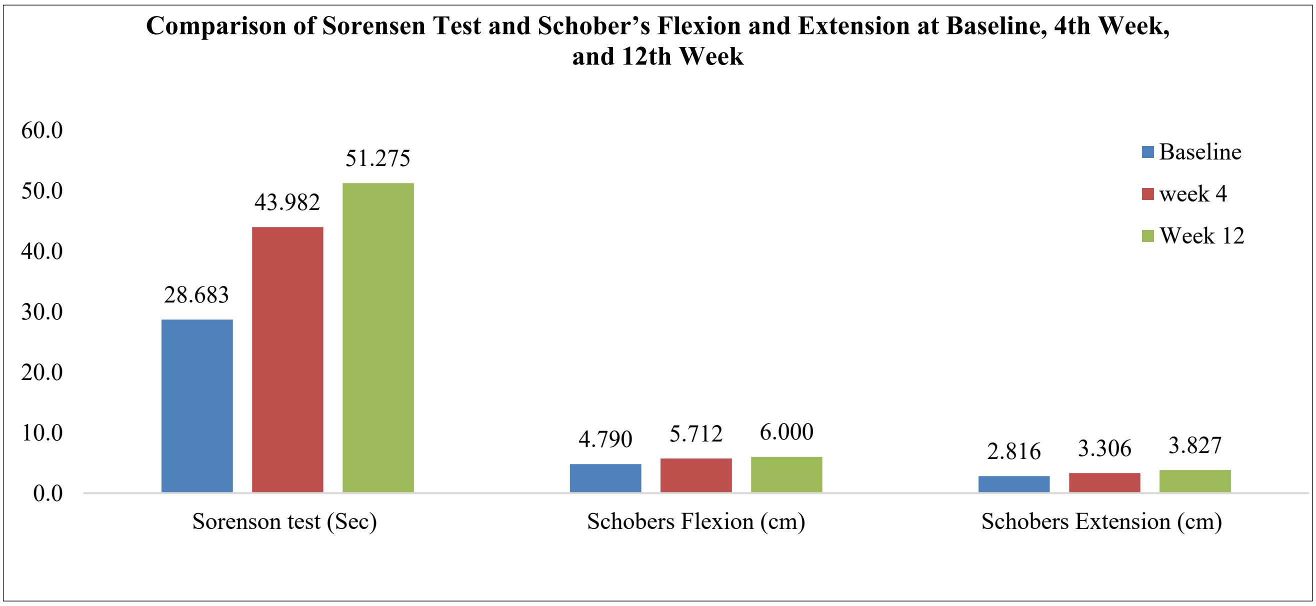

Figure 3: Comparison of functional performance scores (Sorensen test and Schober's flexion and extension) at baseline, 4th week, and 12th week.

Figure 4: Motor control exercise.

Figure 5: Graded flexion.

Figure 6: Side bridge exercise.

Figure 7: Bird dog exercise.

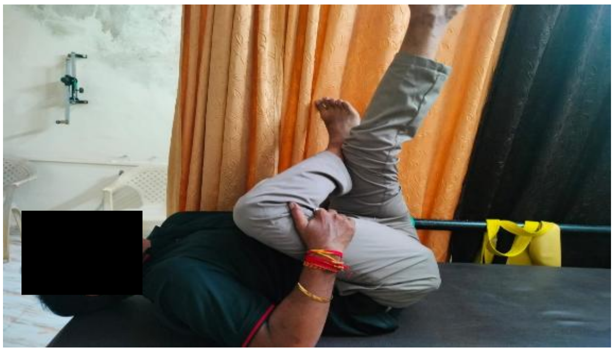

Figure 8: Lying supine pyriformis stretch.

Figure 9: Erecter spinae stretch.

Figures 4-10 represents different types of exercises and stretches.

DISCUSSION

The present study demonstrated significant improvements across all measured outcome parameters—pain intensity (VAS), functional disability (Oswestry disability index), lumbar flexion and extension range of motion (modified Modified Schober's test), and back muscle endurance (Sorensen's test)—following a combined intervention of motor control exercise, lumbar muscle strengthening exercise, and stretching exercise in patients with chronic non-specific low back pain. These findings align with the growing body of evidence supporting multimodal exercise approaches for the management of chronic low back pain and warrant detailed discussion regarding their clinical significance, underlying mechanisms, and implications for rehabilitation practice.

Pain reduction and functional improvement

Exercise treatment has been shown to be effective in treating chronic, non-specific low back pain, and this study's notable decrease in pain intensity is in line with this line of research. The combined intervention approach's better results are consistent with recent systematic evaluations showing that multimodal exercise regimens frequently have more beneficial effects than single-modality therapies.

When compared to exercise alone, Blanco-Giménez et al found that exercise plus manual treatment produced the greatest improvements in disability (ODI), with clinically significant decreases of 54.71%, 63.16%, and 87.70% at 3, 6, and 12 weeks, respectively. Additionally, when compared to no treatment, usual care, or a placebo, a thorough Cochrane review by Hayden et al found moderate-certainty evidence that exercise treatment results in a mean difference of -15.2 points (95% CI -18.3 to -12.2) for pain outcomes and -6.8 points (95% CI -8.3 to -5.3) for functional limitations.[10,27]

Mechanisms underlying motor control exercise effects

By restoring neuromuscular control and segmental spinal stability, the motor control exercise component of the intervention most likely helped to reduce discomfort and enhance function. The deep stabilizing muscles, especially the lumbar multifidus and transversus abdominis, are the focus of motor control exercises. It has been demonstrated that people with persistent low back pain have reduced cross-sectional area and delayed activation patterns in these muscles.[28,29]

Contributions of lumbar muscle strengthening

The intervention's lumbar muscle strengthening component targets the well-established lumbar extensor deconditioning phenomena in people with persistent low back pain. Along with increasing fatty infiltration of the paraspinal musculature, patients with chronic low back pain often have decreased lumbar extensor strength, endurance, and muscle cross-sectional area. Moon et al showed that while dynamic strengthening exercises and lumbar stabilization both increased lumbar extensor strength and decreased low back pain, stabilization exercises had better results at low lumbar flexion degrees and produced more functional gains.[30-32]

Particularly notable are the gains in back muscle endurance as determined by the current study's Sorensen's test. With position-holding durations of fewer than 176 seconds in males indicating an increased risk of low back pain, the Sorensen test has been proven to be a valid predictor of future episodes of low back pain. Berry et al discovered that while high-intensity resistance training for the lumbar extensors increased strength and decreased pain, it had varying effects on muscle morphology. This suggests that neuromuscular adaptations, rather than just muscle hypertrophy, may be the cause of improvements in muscle function.[31,33,34]

Role of stretching exercise

There were several ways in which the stretching exercise component enhanced results. Patients with persistent low back pain often have tightness in their hamstrings and trunk muscles, which can lead to changes in movement patterns, greater spinal loading, and functional restrictions. According to a meta-analysis by Gou et al, hamstring stretching exercises significantly reduced pain scores (SMD=-0.72, 95% CI: -1.35 to -0.09) and ODI scores (MD=-6.97, 95% CI: -13.34 to -0.60) when compared to standard treatment for a variety of low back pain categories.[35,36]

The combined use of passive and active stretching methods most likely helped to enhance the range of motion for lumbar flexion and extension as determined by the modified Schober's test.

Comparison with previous literature

The results of this study are in line with many excellent studies that look at exercise therapies for persistent, non-specific low back pain. In contrast to traditional physiotherapy, Ibrahim et al showed that motor control exercises resulted in noticeably higher improvements in VAS (t=-5.144, p<0.001) and ODI (t=-5.133, p<0.001) scores. For chronic non-specific low back pain, Costa et al also found that motor control exercises produced better results than electrotherapeutic modalities.[37,38]

The positive outcomes of combined exercise regimens seen in this study are consistent with research by Javadipour et al, which showed that combining stretching and core stability exercises alleviated chronic low back pain while also lowering the trunk inclination angle and the severity of lumbar lordosis.

Additionally, Kim et al discovered that while passive stretching and hip exercise together improved flexibility measurements more than lumbar stabilization exercise alone, they generated similar decreases in muscle stiffness and pain (P-VAS ratings).[39,40]

Limitations

When interpreting these results, it is important to recognize a number of limitations. The results' generalizability may be impacted by the intervention's frequency and duration, sample makeup, and follow-up time. Furthermore, even though there were notable gains in every outcome measure, it is impossible to pinpoint how exactly each exercise component—motor control, strengthening, and stretching—contributed to the overall results based on the combined intervention design.

CONCLUSION

This study demonstrates that a combined intervention incorporating motor control exercise, lumbar muscle strengthening exercise, and stretching exercise produces significant and clinically meaningful improvements in pain, functional disability, lumbar range of motion, and back muscle endurance in patients with chronic non-specific low back pain.

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