Evaluating the Efficacy of Core Stabilization Exercises in the Management of Chronic Low Back Pain: A Study on Pain Relief and Functional Improvement

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Abstract

Background: Chronic low back pain (CLBP) is a leading cause of disability worldwide. Core stabilization exercises have been proposed as an effective intervention to reduce pain and improve functional outcomes in patients with CLBP, but their long-term efficacy remains uncertain.

Objective: This study aimed to assess the efficacy of core stabilization exercises in managing CLBP by comparing their impact on pain relief and functional improvement with general exercise therapy.

Methods: A randomized controlled trial was conducted with 80 participants diagnosed with CLBP. Participants were randomly assigned to either a core stabilization exercise group or a general exercise therapy group. Pain intensity was measured using the Visual Analog Scale (VAS), and functional ability was assessed using the Oswestry Disability Index (ODI) at baseline, post-intervention (12 weeks), and at 3-month and 6-month follow-ups.

Results: The core stabilization group demonstrated significantly greater reductions in pain intensity and improvements in functional ability compared to the general exercise group at 12 weeks ($p < 0.01$) and 3 months ($p < 0.05$). However, by the 6-month follow-up, the differences between the groups were not statistically significant. The core stabilization group also showed superior trunk muscle endurance and quality of life scores.

Conclusion: Core stabilization exercises are effective in providing short-term relief from CLBP and improving functional outcomes. However, sustained benefits may require ongoing exercise beyond the initial treatment period.

Keywords: Chronic Low Back Pain, Core Stabilization Exercises, Pain Management, Functional Outcomes, Randomized Controlled Trial.

Introduction

Chronic low back pain (CLBP) is a pervasive and debilitating condition affecting millions of individuals worldwide. It is one of the leading causes of disability and healthcare utilization, often resulting in significant socioeconomic impact due to lost productivity and the cost of treatment (Murray and Lopez, 2013; Vos et al., 2012). CLBP is typically defined as pain in the lumbar region lasting longer than 12 weeks and can be

associated with a variety of factors, including poor posture, muscle weakness, and degenerative changes in the spine (Deyo, 2001).

Conventional treatment approaches for CLBP include pharmacological interventions, physical therapy, and in some cases, surgical procedures. However, the multifactorial nature of CLBP often makes it resistant to treatment, with many patients experiencing persistent pain and functional limitations despite these interventions (Koes et al., 2006). As a result, there has been a growing interest in alternative and adjunctive therapies that target the underlying biomechanical and neuromuscular factors contributing to CLBP.

Core stabilization exercises have emerged as a promising intervention for managing CLBP. These exercises are designed to strengthen the muscles of the core, including the transverse abdominis, multifidus, and pelvic floor muscles, which are essential for maintaining spinal stability and proper biomechanics during movement (Akuthota and Nadler, 2004). The rationale behind core stabilization exercises is based on the theory that a stable core provides a solid foundation for the spine, reducing the load on the lumbar vertebrae and associated structures, thereby alleviating pain and improving function (Hodges and Richardson, 1996).

Several studies have suggested that core stabilization exercises can lead to significant improvements in pain and functional outcomes in patients with CLBP. For instance, a study by Koumantakis et al. (2005) demonstrated that patients who participated in a structured core stabilization exercise program reported greater reductions in pain and disability compared to those who received general exercise or no intervention. Similarly, another study by Shamsi et al. (2016) found that core stabilization exercises were effective in enhancing trunk muscle endurance and reducing pain in individuals with CLBP (Hodges,2003).

Despite these promising findings, there remains a need for further research to solidify the evidence base for core stabilization exercises in CLBP management. Specifically, more studies are needed to investigate the long-term effects of these exercises and their efficacy compared to other therapeutic modalities. This study aims to assess the efficacy of core stabilization exercises in reducing pain and improving functional outcomes in patients with chronic low back pain. By exploring the impact of these exercises, this research seeks to contribute to the development of evidence-based guidelines for the management of CLBP.

Literature Review

Overview of Chronic Low Back Pain (CLBP)

Chronic low back pain (CLBP) is a significant public health concern worldwide, with a high prevalence among adults of various age groups. It is a leading cause of disability, contributing to substantial socioeconomic burden due to healthcare costs and lost (Murray and Lopez, 2013). CLBP is typically characterized by pain and discomfort in the lumbar region lasting more than 12 weeks, often accompanied by limitations in physical function and daily activities (Vos et al., 2012). The etiology of CLBP is multifactorial, involving a combination of mechanical, neurological, and psychological factors. Common contributors include poor posture, muscle imbalances, degenerative changes in the spine, and psychosocial stressors (Deyo, 2001; Koes et al., 2006).

Conventional treatments for CLBP typically include pharmacological interventions, physical therapy, and in some cases, surgical procedures. However, the chronic nature of the condition often results in persistent pain and functional impairments, leading to a search for more effective, long-term management strategies (Hayden et al., 2005). Among the non-pharmacological approaches, exercise therapy has gained prominence as a

cornerstone of CLBP management, with core stabilization exercises emerging as a particularly promising intervention.

Core Stabilization Exercises: Mechanisms and Application

Core stabilization exercises focus on strengthening the muscles of the trunk, including the transverse abdominis, multifidus, pelvic floor, and diaphragm. These muscles are collectively responsible for maintaining spinal stability and providing a stable base for movement of the limbs (Akuthota and Nadler, 2004). The rationale for using core stabilization exercises in CLBP management is based on the theory that enhancing the stability of the core reduces the load on the lumbar spine, thereby alleviating pain and improving function (Hodges and Richardson, 1996).

Several studies have demonstrated the effectiveness of core stabilization exercises in reducing pain and enhancing functional outcomes in patients with CLBP. Akuthota and Nadler (2004) provided a comprehensive review of the role of core muscles in maintaining spinal stability and highlighted the benefits of core strengthening in managing low back pain. They noted that core stabilization exercises not only improve muscle endurance and strength but also enhance neuromuscular control, which is crucial for preventing recurrent episodes of low back pain.

In another study, Hodges and Richardson (1996) explored the relationship between core muscle activation and low back pain, finding that individuals with CLBP exhibited delayed activation of the transverse abdominis muscle, a key stabilizer of the lumbar spine. This delay in muscle activation was associated with poor motor control and increased risk of injury. The study underscored the importance of targeting the core muscles in rehabilitation programs to restore proper motor patterns and reduce the risk of future back pain episodes.

Evidence Supporting Core Stabilization Exercises in CLBP

Research has consistently shown that core stabilization exercises can lead to significant improvements in pain and functional outcomes in patients with CLBP. A randomized controlled trial by Koumantakis et al. (2005) compared the effects of core stabilization exercises with routine exercise therapy in patients with CLBP. The study found that participants in the core stabilization group reported greater reductions in pain and disability, as measured by the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), compared to those in the routine exercise group. These findings suggest that core stabilization exercises may offer superior benefits in managing CLBP, particularly in terms of pain relief and functional improvement.

Similarly, a study by Hodges (2003) examined the impact of core stabilization exercises on dynamic balance and trunk muscle endurance in individuals with CLBP. The results showed that participants who engaged in core stabilization exercises experienced significant improvements in both dynamic balance and trunk endurance, which are critical for maintaining functional mobility and reducing the risk of falls and injuries [9]. This study highlights the broader benefits of core stabilization exercises beyond pain relief, emphasizing their role in enhancing overall physical function.

However, while the evidence supporting core stabilization exercises is robust, some studies have raised questions about their long-term efficacy. For example, a systematic review by Wang et al. (2012) suggested that while core stabilization exercises are effective in the short term, their benefits may diminish over time if not maintained with ongoing practice. This finding underscores the importance of incorporating core

stabilization exercises into long-term rehabilitation programs and encouraging patients to continue these exercises beyond the initial treatment phase.

Gaps in the Literature

Despite the growing body of evidence supporting core stabilization exercises in the management of CLBP, several gaps remain. First, there is a need for more high-quality, long-term studies that examine the sustained effects of core stabilization exercises on pain and function. Most existing studies focus on short-term outcomes, and there is limited research on the long-term adherence to these exercises and their impact on chronic pain management.

Additionally, there is a lack of consensus on the optimal duration, frequency, and intensity of core stabilization exercises for achieving the best outcomes in CLBP patients. Future research should explore these variables to establish evidence-based guidelines for clinical practice.

Finally, while many studies have demonstrated the effectiveness of core stabilization exercises, there is a need for comparative studies that evaluate their efficacy against other forms of exercise therapy, such as general strengthening, stretching, or aerobic exercises. Understanding how core stabilization exercises compare to other interventions will help clinicians tailor treatment plans to the individual needs of patients with CLBP.

Core stabilization exercises have emerged as a valuable intervention in the management of chronic low back pain, offering significant benefits in terms of pain relief and functional improvement. While the evidence supporting their use is strong, further research is needed to address gaps in the literature, particularly regarding the long-term efficacy and optimal implementation of these exercises. By building on the existing evidence, future studies can contribute to the development of more effective, evidence-based treatment strategies for individuals suffering from CLBP.

Methodology

Study Design

This research was conducted as a randomized controlled trial (RCT) to evaluate the efficacy of core stabilization exercises in managing chronic low back pain (CLBP). The study took place over 12 months at a rehabilitation department at a tertiary hospital and aimed to compare the outcomes of patients undergoing core stabilization exercises with those receiving general exercise therapy. The trial focused on measuring pain relief and functional improvement in patients with CLBP.

Participants

A total of 80 participants diagnosed with CLBP were recruited for the study. Participants were eligible if they met the following inclusion criteria:

1. Adults aged 18-65 years.
2. A clinical diagnosis of CLBP, defined as low back pain persisting for more than 12 weeks.
3. No previous history of spinal surgery or significant spinal trauma.
4. Ability to engage in physical exercise as confirmed by a healthcare provider.
5. Willingness to participate in the study and provide informed consent.

Exclusion criteria included:

1. Presence of specific spinal pathologies (e.g., spondylolisthesis, spinal stenosis).
2. Systemic conditions affecting musculoskeletal function (e.g., rheumatoid arthritis, fibromyalgia).

3. Pregnancy.
4. Current participation in other rehabilitation programs or clinical trials.

Randomization and Blinding

Participants were randomly assigned to one of two groups: the intervention group (core stabilization exercises) or the control group (general exercise therapy). Randomization was performed using a computer-generated random number sequence. The assessors responsible for measuring outcomes were blinded to the group allocation to minimize bias.

Intervention

Intervention Group (Core Stabilization Exercises): Participants in the intervention group engaged in a structured core stabilization exercise program tailored to strengthen the deep muscles of the trunk, including the transverse abdominis, multifidus, and pelvic floor muscles. The program consisted of exercises such as pelvic tilts, bridges, and planks, performed three times per week for 12 weeks. Each session lasted approximately 45 minutes and was supervised by a trained physiotherapist. The intensity and difficulty of the exercises were progressively increased based on individual participant progress.

Control Group (General Exercise Therapy): Participants in the control group received a general exercise therapy program focused on overall fitness and mobility. This program included a combination of aerobic exercises (e.g., walking, cycling) and general strengthening exercises (e.g., leg presses, back extensions), also performed three times per week for 12 weeks. Each session lasted approximately 45 minutes and was supervised by a trained physiotherapist.

Outcome Measures

The primary outcome measures were pain intensity and functional ability, assessed at baseline, immediately after the 12-week intervention, and at follow-up intervals of 3 months and 6 months post-intervention.

- Pain Intensity: Pain levels were measured using the Visual Analog Scale (VAS), where participants rated their pain on a scale from 0 (no pain) to 10 (worst possible pain).
- Functional Ability: Functional outcomes were assessed using the Oswestry Disability Index (ODI), a widely used questionnaire that measures the degree of disability and impact of low back pain on daily activities.

Secondary outcome measures included:

- Trunk Muscle Endurance: Assessed using the Sorensen test for back extensor endurance and a timed side plank test for lateral core endurance.
- Quality of Life: Evaluated using the Short Form Health Survey (SF-36), with a focus on the physical functioning and bodily pain domains.
- Adherence to the Exercise Program: Monitored through participant logs and physiotherapist records, noting attendance and completion of exercises.

Data Collection

Data were collected at four key time points: baseline (pre-intervention), immediately post-intervention (12 weeks), and at 3-month and 6-month follow-ups. Participants attended in-person assessments at the rehabilitation center, where all evaluations were conducted by trained assessors blinded to group allocation.

Statistical Analysis

Data were analyzed using SPSS software (version 26.0). Descriptive statistics were used to summarize participant characteristics and baseline measures. The primary outcomes (pain intensity and functional ability) were analyzed using repeated-measures ANOVA to compare changes over time between the two groups. Post-hoc analyses with Bonferroni correction were conducted to identify specific time points at which differences occurred.

For secondary outcomes, independent t-tests were used to compare trunk muscle endurance and quality of life scores between groups. Chi-square tests were employed to assess differences in adherence rates. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and was approved by the ethics committee. All participants provided written informed consent prior to participation. The confidentiality and anonymity of participant data were strictly maintained, and participants were informed of their right to withdraw from the study at any time without penalty.

Findings

This study aimed to evaluate the efficacy of core stabilization exercises in managing chronic low back pain (CLBP) by comparing pain relief and functional improvement between the intervention group (core stabilization exercises) and the control group (general exercise therapy). The results are presented below, highlighting key outcomes at baseline, immediately post-intervention (12 weeks), and at follow-up intervals of 3 months and 6 months.

Pain Intensity

Pain intensity was assessed using the Visual Analog Scale (VAS). The results are summarized in Table 1.

Table 1: Mean VAS Pain Scores at Different Time Points

Time Point	Intervention Group (Core Stabilization)	Control Group (General Exercise)	p-value
Baseline	7.2 ±1.3	7.1 ±1.4	0.78
Post-Intervention (12 weeks)	3.8 ±1.0	5.1 ±1.2	0.002**
3 Months	3.5 ±1.2	4.7 ±1.3	0.01*
6 Months	4.1 ±1.3	4.8 ±1.4	0.08

*Statistically significant at $p < 0.05$.
**Statistically significant at $p < 0.01$.

Key Findings:

- Both groups exhibited significant reductions in pain intensity from baseline to post-intervention (12 weeks).
- The intervention group experienced a greater reduction in pain intensity immediately post-intervention ($p = 0.002$) and at the 3-month follow-up ($p = 0.01$) compared to the control group.
- By the 6-month follow-up, the difference in pain intensity between the two groups was not statistically significant ($p = 0.08$).

Functional Ability

Functional ability was assessed using the Oswestry Disability Index (ODI). The results are summarized in Table 2.

Table 2: Mean ODI Scores at Different Time Points

Time Point	Intervention Group (Core Stabilization)	Control Group (General Exercise)	p-value
Baseline	42.5 ±8.6	43.0 ±8.4	0.73
Post-Intervention (12 weeks)	24.1 ±6.7	30.3 ±7.2	0.001**
3 Months	22.8 ±6.5	28.9 ±7.4	0.003**
6 Months	25.2 ±6.9	28.1 ±7.3	0.09

**Statistically significant at $p < 0.01$.

Key Findings:
- The intervention group showed significantly greater improvements in functional ability immediately post-intervention ($p = 0.001$) and at the 3-month follow-up ($p = 0.003$) compared to the control group.
- The differences in ODI scores between the groups diminished by the 6-month follow-up, with no statistically significant difference ($p = 0.09$).

Trunk Muscle Endurance

Trunk muscle endurance was assessed using the Sorensen test for back extensor endurance and the timed side plank test for lateral core endurance. The results are summarized in Table 3.

Table 3: Mean Trunk Muscle Endurance Scores

Outcome Measure	Intervention Group (Core Stabilization)	Control Group (General Exercise)	p-value
Back Extensor Endurance (seconds)	110.2 ±15.8	95.4 ±14.3	0.004**
Lateral Core Endurance (seconds)	85.7 ±13.6	72.3 ±12.9	0.002**

**Statistically significant at $p < 0.01$.

Key Findings:
- The intervention group demonstrated significantly greater trunk muscle endurance in both the back extensor and lateral core endurance tests compared to the control group ($p < 0.01$).

Quality of Life

Quality of life was assessed using the SF-36 survey, focusing on the physical functioning and bodily pain domains. The findings are presented in Table 4.

Table 4: Mean SF-36 Scores (Physical Functioning and Bodily Pain Domains) at 6 Months

SF-36 Domain	Intervention Group (Core Stabilization)	Control Group (General Exercise)	p-value
Physical Functioning	82.4 ±7.9	77.1 ±7.4	0.03*
Bodily Pain	74.8 ±8.2	69.3 ±7.6	0.04*

*Statistically significant at $p < 0.05$.

Key Findings:
- The intervention group reported significantly better scores in both physical functioning ($p = 0.03$) and bodily pain ($p = 0.04$) at the 6-month follow-up compared to the control group.

Adherence to the Exercise Program

Adherence to the exercise programs was high in both groups, with no significant differences in adherence rates, indicating that the observed differences in outcomes are likely attributable to the intervention rather than variations in adherence.

Discussion

Interpretation of Findings

The results of this study provide strong evidence supporting the efficacy of core stabilization exercises in the management of chronic low back pain (CLBP). Participants who engaged in a structured core stabilization exercise program experienced significantly greater reductions in pain intensity and improvements in functional ability compared to those who participated in general exercise therapy. These findings are consistent with previous research that has highlighted the benefits of core stabilization exercises in enhancing spinal stability, reducing pain, and improving function in patients with CLBP (Murray and Lopez, 2013; Vos et al., 2012).

The significant reduction in pain intensity observed in the core stabilization group at both the post-intervention (12 weeks) and 3-month follow-up intervals underscores the effectiveness of these exercises in providing short-term relief from CLBP. This can be attributed to the strengthening of deep trunk muscles, such as the transverse abdominis and multifidus, which play a crucial role in stabilizing the spine and reducing mechanical stress on the lumbar vertebrae (Deyo, 2001). Improved neuromuscular control and enhanced endurance of these core muscles likely contributed to the observed decrease in pain and disability.

Moreover, the superior functional outcomes in the core stabilization group, as measured by the Oswestry Disability Index (ODI), suggest that these exercises not only alleviate pain but also enhance patients ’ability to perform daily activities. The significant improvements in trunk muscle endurance observed in the Sorensen and side plank tests further support the notion that core stabilization exercises enhance the physical capacity required to maintain proper posture and perform movements without exacerbating pain (Koes et al., 2006).

However, it is important to note that the differences between the core stabilization and general exercise groups diminished by the 6-month follow-up. While the core stabilization group continued to exhibit better outcomes in terms of pain intensity, functional ability, and quality of life, the differences were not statistically significant. This finding suggests that while core stabilization exercises are effective in the short term, their benefits may not be sustained without continued practice. This is consistent with previous research indicating

that ongoing exercise is necessary to maintain the therapeutic effects of rehabilitation programs for CLBP (Hayden et al., 2005).

Clinical Implications

The findings of this study have important implications for clinical practice in the management of chronic low back pain. Core stabilization exercises should be considered a key component of rehabilitation programs for patients with CLBP, particularly in the early stages of treatment when rapid pain relief and functional improvement are critical. Clinicians may recommend core stabilization exercises as an effective strategy to enhance spinal stability, reduce pain, and improve patients 'ability to perform daily activities.

However, given the observed reduction in the long-term efficacy of core stabilization exercises, it is essential for clinicians to emphasize the importance of ongoing exercise beyond the initial treatment phase. Patients should be encouraged to continue core stabilization exercises as part of their long-term self-management strategy to maintain the benefits achieved during the initial rehabilitation period. Additionally, integrating these exercises with other forms of physical activity, such as aerobic or flexibility exercises, may help sustain the positive outcomes over time.

Strengths and Limitations

This study has several strengths that contribute to the robustness of its findings. The randomized controlled trial design, along with the use of validated outcome measures such as the Visual Analog Scale (VAS) and Oswestry Disability Index (ODI), ensured a high level of methodological rigor. The study also included a comprehensive assessment of trunk muscle endurance and quality of life, providing a well-rounded evaluation of the impact of core stabilization exercises on CLBP.

However, there are also limitations to consider. The sample size, while adequate for detecting significant differences in primary outcomes, may limit the generalizability of the findings to a broader population. Additionally, the study did not include a placebo or sham exercise group, which would have helped to further isolate the specific effects of core stabilization exercises from potential placebo effects. Finally, the follow-up period of 6 months, while sufficient to assess medium-term outcomes, may not fully capture the long-term efficacy of the intervention. Future studies with longer follow-up periods are needed to evaluate the sustained impact of core stabilization exercises on CLBP.

Future Research

The results of this study suggest several avenues for future research. First, larger studies with more diverse populations are needed to confirm the findings and explore the generalizability of core stabilization exercises across different demographic groups. Additionally, future research should investigate the long-term adherence to core stabilization exercises and the factors that influence patients 'commitment to ongoing exercise after the initial rehabilitation period.

Comparative studies that evaluate the efficacy of core stabilization exercises against other forms of exercise therapy, such as stretching, aerobic exercise, or yoga, would also be valuable. Such studies could help determine the relative benefits of different exercise modalities and inform more personalized treatment plans for patients with CLBP.

Finally, exploring the psychological and behavioral aspects of exercise adherence, including the role of motivation, self-efficacy, and patient education, could provide insights into how to improve long-term outcomes for individuals with CLBP.

Conclusion

In conclusion, this study demonstrates that core stabilization exercises are an effective intervention for managing chronic low back pain, offering significant benefits in terms of pain relief and functional improvement in the short term. However, the long-term maintenance of these benefits may require ongoing exercise beyond the initial treatment period. Clinicians should consider incorporating core stabilization exercises into their treatment protocols for CLBP and encourage patients to continue these exercises as part of a long-term self-management strategy. Further research is needed to explore the sustained efficacy of core stabilization exercises and to identify strategies for improving long-term adherence and outcomes.

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