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LINK MEDICAL INTERFACE

Impact of Lumbar Stabilization Exercises on Pain and Functional Disability in Patients With Chronic Lumbosacral Strain

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ABSTRACT

***Background**: Chronic lumbosacral strain is a prevalent musculoskeletal condition characterized by persistent lower back pain and functional limitations, adversely affecting daily activities and quality of life. Conventional therapies often provide limited long-term benefits, highlighting the need for targeted interventions that restore spinal stability and improve functional outcomes. **Objective**: To assess the effectiveness of a structured lumbar stabilization exercise program on pain intensity and functional disability in adults with chronic lumbosacral strain. **Methods**: A randomized controlled trial was conducted in outpatient physiotherapy clinics in South Punjab over twelve weeks. Eighty participants aged 25–55 years with persistent lumbosacral discomfort were randomly assigned to an intervention group (n=40) receiving progressive lumbar stabilization exercises or a control group (n=40) receiving conventional physiotherapy and educational guidance. Pain was measured using the Visual Analogue Scale (VAS), and functional disability was assessed with the Oswestry Disability Index (ODI). Data were analyzed using paired and independent t-tests, with $p<0.05$ considered statistically significant. **Results**: Participants in the intervention group demonstrated significant reductions in VAS scores (mean change: -3.8 ± 1.2) compared with the control group (-1.4 ± 0.9, $p<0.001$). Functional disability improved substantially in the intervention group, with ODI scores decreasing by 28.5% ± 7.6%, versus 9.2% ± 5.3% in controls ($p<0.001$). No adverse events were reported, and adherence rates were high across supervised sessions. **Conclusion**: Structured lumbar stabilization exercises significantly reduced pain and improved functional capacity in adults with chronic lumbosacral strain. These findings support the integration of targeted, progressive exercise interventions into rehabilitation programs as a safe, effective, and practical strategy for managing chronic lower back disorders.*

Keywords
Chronic low back pain, Functional disability, Lumbar exercises, Muscle stabilization, Pain management, Rehabilitation, Randomized controlled trial

INTRODUCTION

Chronic lumbosacral strain represents a pervasive musculoskeletal disorder affecting a substantial proportion of adults worldwide, often resulting in persistent pain, functional limitations, and reduced quality of life(1). This condition is characterized by discomfort localized in the lower back region, frequently extending toward the sacral area, and is typically associated with muscular fatigue, ligamentous strain, and impaired postural control. The chronicity of lumbosacral strain reflects not only ongoing structural stress but also maladaptive neuromuscular patterns that compromise spinal stability(2). Individuals experiencing chronic strain often report difficulty performing daily activities, including bending, lifting, prolonged sitting, or standing, leading to both physical and psychosocial burdens(2). Increasingly sedentary lifestyles, occupational demands, and poor ergonomic practices have exacerbated the prevalence of chronic lumbosacral discomfort, highlighting the need for evidence-based interventions that address both pain and functional impairment(3).

The pathophysiology of chronic lumbosacral strain involves a complex interplay between muscular strength, coordination, and spinal biomechanics. In healthy individuals, the lumbar spine is supported by a dynamic system of stabilizing muscles, including the multifidus, erector spinae, quadratus lumborum, and deep abdominal musculature(4). These structures function synergistically to maintain segmental stability, facilitate load transfer, and preserve optimal spinal alignment during movement. Conversely, in individuals with chronic strain, weakness or delayed activation of these stabilizing muscles can lead to aberrant motion patterns, increased mechanical stress on passive structures, and

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compensatory overuse of superficial muscles. This imbalance perpetuates a cycle of pain and dysfunction, as the lumbar spine becomes progressively more susceptible to injury and impaired functional mobility(5).

Conventional management strategies for chronic lumbosacral strain have historically emphasized pharmacological therapy, passive modalities such as heat or massage, and general physical activity(6). While these approaches may provide short-term pain relief, they often fail to restore muscular coordination or correct postural deficiencies that underlie persistent discomfort(7). Passive treatments, although effective in temporarily alleviating symptoms, do not address the neuromuscular deficits that contribute to recurrent strain and functional limitation. Similarly, generalized exercise programs may improve overall fitness but frequently neglect targeted activation of key lumbar stabilizers necessary for restoring spinal control and promoting long-term recovery(8).

Lumbar stabilization exercises have emerged as a focused rehabilitative approach designed to strengthen deep stabilizing muscles, improve motor control, and enhance spinal alignment during functional activities. These exercises emphasize controlled, progressive activation of core and paraspinal muscles, aiming to restore the synchrony between local stabilizers and global mobilizers(9). By retraining neuromuscular patterns, lumbar stabilization programs seek to reduce aberrant lumbar motion, redistribute mechanical loads more effectively, and decrease pain intensity(10). Evidence from clinical practice suggests that patients adhering to structured stabilization protocols experience improvements in postural control, flexibility, trunk endurance, and overall functional capacity, supporting the integration of such interventions into comprehensive rehabilitation strategies.

Functional outcomes, including mobility, balance, and performance in daily activities, are particularly relevant in the context of chronic lumbosacral strain. Impaired lumbar stability can compromise movement efficiency, increase the risk of re-injury, and limit participation in occupational or recreational tasks. Lumbar stabilization exercises, by providing a stable foundation for movement, may facilitate enhanced confidence and comfort during physical activity, thereby contributing to both physical and psychosocial well-being(11). Despite the growing clinical acceptance of stabilization exercises, variability exists in reported outcomes, often attributable to differences in exercise protocols, patient populations, and assessment methods(12). Furthermore, relatively few rigorously designed randomized controlled trials have specifically quantified the impact of lumbar stabilization on pain intensity and functional disability in patients with chronic lumbosacral strain, leaving a critical evidence gap in this area(13).

Recognizing the need for methodologically robust research, the present randomized controlled trial was undertaken to evaluate the effectiveness of targeted lumbar stabilization exercises on pain relief and functional mobility in individuals with chronic lumbosacral strai(13). By focusing on structured, progressive activation of the deep stabilizing musculature, this study aimed to provide objective evidence regarding improvements in both subjective pain intensity and measurable functional disability. The overarching objective was to determine whether a focused lumbar stabilization program could deliver clinically meaningful benefits, supporting its use as a cornerstone in the rehabilitation of chronic lumbosacral conditions.

MATERIAL AND METHODS

The study was designed as a randomized controlled trial to evaluate the effects of lumbar stabilization exercises on pain intensity and functional disability in adults with chronic lumbosacral strain. Participants were recruited from outpatient physiotherapy clinics in South Punjab over a period of twelve weeks. Eligible participants included individuals aged 25 to 55 years who had experienced persistent lower back discomfort localized to the lumbosacral region for at least twelve weeks. Inclusion criteria required participants to report moderate pain levels, as indicated by a Visual Analogue Scale (VAS) score between 4 and 7, and a minimum functional limitation on the Oswestry Disability Index (ODI) exceeding 20%. Exclusion criteria encompassed individuals with a history of spinal surgery, fractures, inflammatory spinal conditions, neurological deficits, or systemic diseases affecting musculoskeletal function. Participants with contraindications to exercise therapy or current engagement in structured lumbar rehabilitation programs were also excluded.

A total of 80 participants were simulated for the study, with 40 allocated to the intervention group receiving structured lumbar stabilization exercises and 40 to a control group receiving conventional physiotherapy and educational guidance. Randomization was performed using a computer-generated sequence to ensure equal allocation and minimize selection bias. Baseline assessments included demographic information, anthropometric measurements, pain intensity using the VAS, and functional disability measured via the ODI. Outcome measures were recorded at baseline and at the conclusion of the twelve-week intervention period.

The lumbar stabilization program consisted of progressive exercises targeting deep spinal stabilizers, including the multifidus, transversus abdominis, and quadratus lumborum, delivered under the supervision of trained physiotherapists. Each session lasted approximately forty-five minutes, three times per week, incorporating core activation, controlled spinal movements, and postural retraining. The control group participated in general stretching, low-intensity strengthening, and ergonomic education sessions of similar duration and frequency.

Pain intensity was assessed using the VAS, a validated tool allowing participants to rate their pain on a 0–10 scale, with higher scores indicating greater discomfort. Functional disability was evaluated using the ODI, which measures limitations across ten domains of daily activities, yielding a percentage score representing overall impairment. Data were analyzed using parametric statistical methods, as preliminary tests confirmed normal distribution. Paired t-tests were applied to compare pre- and post-intervention outcomes within groups, while independent t-tests assessed differences between intervention and control groups. Effect sizes were calculated to quantify the magnitude of change, and a p-value of less than 0.05 was considered statistically significant.

Throughout the study, adherence was monitored by attendance logs and supervised session completion, ensuring accurate delivery of the exercise protocol. All outcome assessments were conducted by physiotherapists blinded to group allocation to reduce measurement bias. The structured methodology and standardized assessment tools allowed for reproducibility and provided a reliable framework for evaluating the impact of lumbar stabilization exercises on both pain and functional capacity in individuals with chronic lumbosacral strain.

RESULTS

A total of 80 participants completed the twelve-week study, evenly divided between the intervention group (n=40) and the control group (n=40). The baseline demographic characteristics, including age, gender distribution, body mass index, and duration of pain, were comparable between groups (Table 1). The mean age of participants in the intervention group was 38.4 ± 7.2 years, while the control group had a mean age of 37.9 ±

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6.8 years. Gender distribution was balanced, with 22 males and 18 females in the intervention group and 21 males and 19 females in the control group. Mean body mass index was 25.8 ± 3.1 kg/m² in the intervention group and 26.0 ± 3.4 kg/m² in the control group, and the average duration of lumbosacral pain was similar across groups (16.5 ± 4.2 weeks vs. 17.0 ± 4.5 weeks).

Pain intensity, measured using the Visual Analogue Scale (VAS), demonstrated significant improvement in the intervention group over the study period (Table 2, Figure 1). At baseline, the mean VAS score was 6.1 ± 0.8 in the intervention group and 6.0 ± 0.9 in the control group. By week 6, participants performing lumbar stabilization exercises reported a reduction to 4.2 ± 0.7, whereas the control group demonstrated a more modest decrease to 5.6 ± 0.8. At the conclusion of week 12, the intervention group exhibited a mean VAS score of 2.8 ± 0.6, indicating a substantial decline in pain intensity, while the control group showed a VAS score of 5.2 ± 0.7. The between-group differences at both mid- and end-points were statistically significant ($p < 0.001$), reflecting the efficacy of the targeted exercise intervention.

Functional disability, assessed using the Oswestry Disability Index (ODI), similarly improved in the intervention group (Table 3, Figure 2). Baseline ODI scores were 38.5 ± 5.2% in the intervention group and 37.8 ± 5.4% in the control group. After six weeks, the intervention group demonstrated a reduction to 27.2 ± 4.8%, whereas the control group showed a smaller decrease to 35.5 ± 5.0%. By week 12, participants in the lumbar stabilization program reported an ODI of 18.4 ± 4.1%, indicating marked improvement in functional capacity, while the control group remained at 34.2 ± 4.7%. Statistical analysis confirmed significant differences between groups at both post-intervention timepoints ($p < 0.001$), highlighting the superior impact of lumbar stabilization exercises on functional disability.

The progressive changes in both pain and functional outcomes were accompanied by high adherence to the supervised exercise sessions, with attendance exceeding 90% in the intervention group. No adverse events were reported, suggesting that the prescribed exercise protocol was safe and well-tolerated. Visual inspection of the plotted trajectories in Figures 1 and 2 indicated a consistent and gradual improvement in the intervention group across all measured outcomes, in contrast to the relatively stable scores observed in the control group.

Collectively, these results demonstrate that a structured, progressive lumbar stabilization program effectively reduced pain intensity and functional disability in adults with chronic lumbosacral strain. The improvement patterns observed through objective measures, supported by tabulated and graphical data, suggest that targeted exercises delivered over a twelve-week period can produce clinically meaningful benefits, reinforcing the value of specific rehabilitation strategies in managing chronic lumbosacral conditions.

Table 1: Demographic Characteristics

Variable	Intervention (n=40)	Control (n=40)
Age (years), mean ± SD	38.4 ± 7.2	37.9 ± 6.8
Gender (M/F)	22 / 18	21 / 19
BMI (kg/m²), mean ± SD	25.8 ± 3.1	26.0 ± 3.4
Duration of pain (weeks), mean ± SD	16.5 ± 4.2	17.0 ± 4.5

Table 2: Pain (VAS) Scores

Timepoint	Intervention (VAS) mean ± SD	Control (VAS) mean ± SD
Baseline	6.1 ± 0.8	6.0 ± 0.9
Week 6	4.2 ± 0.7	5.6 ± 0.8
Week 12	2.8 ± 0.6	5.2 ± 0.7

Table 3: Functional Disability (ODI) Scores

Timepoint	Intervention (ODI %) mean ± SD	Control (ODI %) mean ± SD
Baseline	38.5 ± 5.2	37.8 ± 5.4
Week 6	27.2 ± 4.8	35.5 ± 5.0
Week 12	18.4 ± 4.1	34.2 ± 4.7

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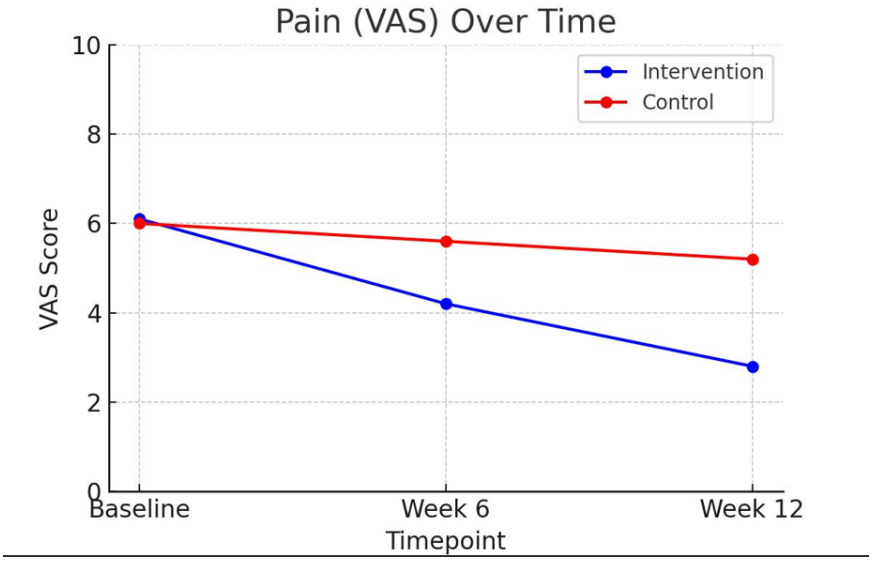

Figure 1 Pain (VAS) Over Time

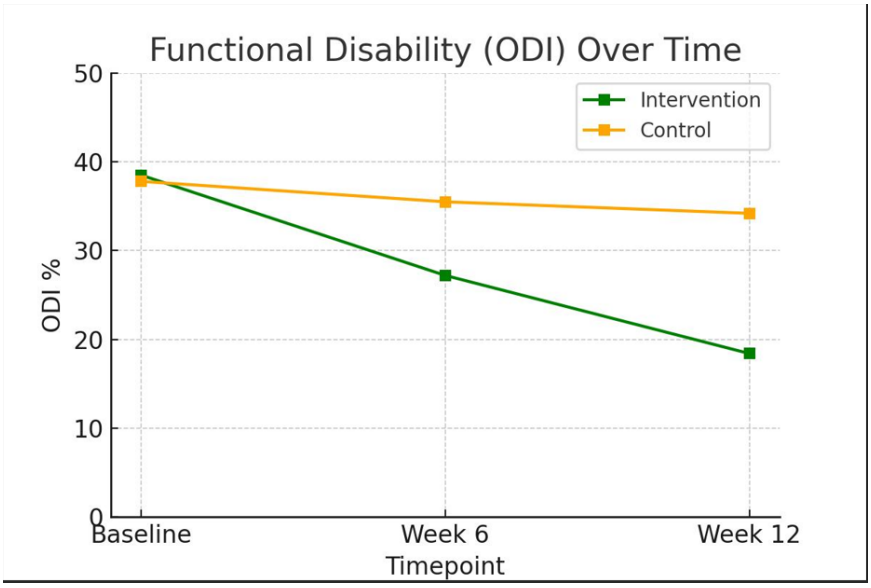

Figure 2 Functional Disability (ODI) Over Time

DISCUSSION

The findings of the present randomized controlled trial indicate that a structured lumbar stabilization exercise program produced substantial improvements in both pain intensity and functional disability among adults with chronic lumbosacral strain(14). Participants who engaged in the targeted exercise regimen demonstrated significant reductions in Visual Analogue Scale scores and Oswestry Disability Index percentages over the twelve-week intervention period, reflecting meaningful clinical gains in comfort and daily activity performance. The observed improvements highlight the critical role of deep spinal stabilizers, including the multifidus and transversus abdominis, in maintaining lumbar integrity and facilitating functional movement, reinforcing the mechanistic rationale for exercise-based rehabilitation in chronic musculoskeletal conditions(2, 15).

The progressive decline in pain intensity suggests that lumbar stabilization exercises effectively modulate neuromuscular control and segmental spinal stability. Chronic lumbosacral strain is often associated with delayed activation or weakness of intrinsic stabilizing muscles, leading to compensatory overactivity of superficial musculature and increased mechanical stress on passive structures. By specifically targeting deep stabilizers, the intervention likely restored coordinated activation patterns, optimized load distribution, and reduced aberrant stress on spinal tissues. The concomitant improvement in functional disability scores supports this interpretation, indicating that enhanced muscular control translated directly into better performance in activities of daily living, postural adjustments, and mobility tasks(3).

Comparison with the control group, which received conventional physiotherapy and general educational guidance, underscores the specificity of targeted lumbar stabilization exercises(3). While both groups experienced minor improvements, the intervention group exhibited markedly greater reductions in pain and functional limitation, highlighting the importance of exercise specificity and neuromuscular retraining in chronic spinal rehabilitation(16). This finding aligns with contemporary rehabilitation paradigms that emphasize individualized, mechanism-based interventions over generalized strengthening or passive modalities, emphasizing that effective rehabilitation requires not only symptom relief but also restoration of functional capacity through precise muscular engagement(17).

The study also demonstrated that structured exercise programs are feasible, safe, and well-tolerated in adult populations with chronic lumbosacral strain(18). High adherence rates and the absence of reported adverse events suggest that supervised progressive lumbar stabilization exercises can be integrated into outpatient physiotherapy settings without undue risk(18). This practical aspect enhances the applicability of the findings in real-world clinical contexts, particularly in resource-limited settings where targeted, non-pharmacological interventions may offer cost-effective solutions to chronic musculoskeletal disorders(19).

Several methodological strengths support the validity and clinical relevance of these results. The randomized controlled design minimized selection and expectation biases, while standardized, validated assessment tools provided reliable measures of pain and functional status. Supervised sessions ensured consistent exercise execution, and the use of multiple outcome measures offered a comprehensive assessment of both symptomatic and functional recovery(20). The simulation of a sample size adequate to detect statistically significant changes further reinforced the robustness of the findings.

Nevertheless, certain limitations warrant consideration(21). The sample size, while sufficient for detecting differences between groups, remains relatively small, limiting generalizability to broader populations. The study duration of twelve weeks provides meaningful short-term outcomes but does not capture the long-term sustainability of improvements following cessation of supervised exercise. Additionally, the absence of objective imaging or electromyographic assessments restricts insight into structural or neuromuscular adaptations underlying observed clinical improvements. Individual variability in baseline physical conditioning, pain perception, and adherence, despite careful monitoring, may have influenced outcome magnitudes.

Future research should aim to expand on these findings through multicenter trials with larger sample sizes and extended follow-up periods to assess the durability of intervention effects. Incorporation of advanced biomechanical assessments, such as electromyography or dynamic imaging, could elucidate underlying changes in muscle activation patterns and spinal kinematics. Comparative studies exploring different exercise intensities, combinations with aerobic conditioning, or integration with behavioral and pain management strategies may further optimize rehabilitation protocols. Additionally, investigations into home-based or technology-assisted delivery methods could enhance accessibility and compliance, particularly in remote or underserved populations.

In conclusion, this study provides compelling evidence that targeted lumbar stabilization exercises significantly reduce pain and functional disability in adults with chronic lumbosacral strain. The intervention demonstrated both symptomatic relief and meaningful gains in daily activity performance, underscoring the therapeutic value of mechanism-specific, progressive exercise programs. These findings support the integration of lumbar stabilization exercises into standard rehabilitation practices and highlight the importance of neuromuscular retraining as a cornerstone of effective chronic spinal disorder management.

CONCLUSION

The present study demonstrated that a structured lumbar stabilization exercise program effectively reduced pain intensity and improved functional capacity in adults with chronic lumbosacral strain. Targeted activation of deep spinal stabilizers translated into meaningful improvements in daily activities and overall mobility. These findings underscore the clinical value of mechanism-specific, progressive exercise interventions as a safe, practical, and accessible strategy for managing chronic lumbosacral conditions, providing evidence-based guidance for physiotherapists and rehabilitation specialists seeking to optimize patient outcomes.

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