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Original Article

Oral Versus Topical NSAIDs Combined with Lumbar Stabilization Exercises in Chronic Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Background: Chronic low back pain is a major cause of disability worldwide and often requires multimodal management that balances efficacy with long-term safety. Oral NSAIDs are widely used but are associated with systemic adverse effects, whereas topical NSAIDs may offer comparable analgesic benefit with better tolerability. Objective: To compare the effectiveness and safety of oral versus topical NSAIDs when combined with lumbar stabilization exercises in individuals with chronic low back pain. Methods: A parallel-group randomized controlled trial was conducted in 100 participants with non-specific chronic low back pain. Participants were allocated to oral NSAIDs plus lumbar stabilization exercises or topical diclofenac gel plus the same exercise program for six weeks. Pain intensity was assessed using the Numeric Pain Rating Scale, functional disability using the Oswestry Disability Index, and adverse events using a structured checklist. Data were analyzed using mixed ANOVA under intention-to-treat principles. Results: Both groups demonstrated significant improvement over time in pain and disability. NPRS decreased from 6.92 ± 1.31 to 2.71 ± 0.96 in the oral NSAID group and from 6.78 ± 1.42 to 2.94 ± 1.02 in the topical NSAID group, with no significant between-group difference at week 6 (p=0.089). ODI improved from 42.6 ± 8.9 to 22.8 ± 6.3 and from 41.8 ± 9.1 to 24.6 ± 6.9, respectively (p=0.11). Adverse events were more frequent with oral NSAIDs (38% vs 22%; p=0.041). Conclusion: Oral and topical NSAIDs provided comparable short-term clinical benefit when combined with lumbar stabilization exercises, but topical NSAIDs demonstrated superior safety. Keywords: chronic low back pain, NSAIDs, topical diclofenac, lumbar stabilization, rehabilitation, randomized controlled trial.

INTRODUCTION

Chronic low back pain (CLBP) is among the most prevalent and disabling musculoskeletal disorders worldwide and remains a major contributor to reduced physical function, work limitation, and long-term healthcare utilization. Its burden extends beyond pain alone, affecting quality of life, mobility, productivity, and psychosocial wellbeing across economically active age groups. Contemporary evidence indicates that CLBP is not merely a symptom of tissue pathology but a complex clinical condition shaped by interactions among biomechanical dysfunction, altered motor control, pain sensitization, and contextual psychosocial influences. This multidimensional nature makes treatment difficult and explains why single-modality approaches often yield only partial or short-lived benefit (1-4).

Non-steroidal anti-inflammatory drugs (NSAIDs) remain one of the most frequently used pharmacological options for CLBP because of their accessibility, affordability, and established analgesic and anti-inflammatory effects. By inhibiting cyclooxygenase-mediated prostaglandin synthesis, NSAIDs may reduce pain sufficiently to improve movement tolerance and daily function. However, the clinical benefit of oral NSAIDs in chronic spinal pain is generally modest, and their sustained use is limited by well-recognized gastrointestinal, renal, and cardiovascular risks. In chronic conditions that often require repeated or prolonged treatment, these safety concerns are not secondary considerations; they directly influence the overall therapeutic value of the intervention and the appropriateness of continued prescribing in routine practice (5-8).

Topical NSAIDs have gained increasing attention as a potentially safer alternative because they deliver the active agent locally while minimizing systemic exposure. Their pharmacokinetic profile allows higher drug concentrations at the site of application with substantially lower plasma levels than oral formulations, theoretically preserving analgesic benefit while reducing the likelihood of systemic adverse events. Evidence from osteoarthritis and other chronic musculoskeletal pain conditions suggests that topical diclofenac and similar preparations can provide clinically meaningful symptom relief with better tolerability than oral NSAIDs. Despite this promise, the direct evidence base for topical NSAIDs in CLBP remains comparatively limited, and their role in spinal rehabilitation has not been defined with the same clarity as in peripheral musculoskeletal disorders (9-13).

At the same time, clinical practice guidelines increasingly recommend non-pharmacological care, particularly exercise-based interventions, as a core component of CLBP management. Among these approaches, lumbar stabilization exercises are especially relevant because they target impairments in deep trunk muscle activation, segmental spinal control, and functional load transfer. Deficits in the transversus abdominis, multifidus, and associated stabilizing systems have been repeatedly linked with persistent low back pain, altered movement strategies, and recurrence risk. By restoring neuromuscular control and improving dynamic stability, lumbar stabilization programs seek not only to reduce symptoms but also to address the mechanical and motor-control dysfunctions that contribute to chronicity. Their value therefore extends beyond short-term pain relief toward longer-term functional restoration and self-management (14-17).

Nevertheless, exercise therapy alone may be difficult to implement effectively in patients with substantial pain at baseline. Pain during movement can reduce confidence, limit participation, and compromise adherence to rehabilitation. This creates a clinically important rationale for combining structured exercise with symptom-relieving pharmacological support. In this multimodal context, NSAIDs may act as enabling agents rather than stand-alone treatments, allowing patients to engage more effectively in therapeutic exercise while the exercise program addresses the underlying functional deficits. Although this integrated model reflects real-world management, much of the published literature has evaluated drug therapy and exercise therapy separately, leaving an important evidence gap regarding how different pharmacological options perform when paired with standardized rehabilitation strategies (17-19).

A further unresolved issue concerns whether the route of NSAID administration meaningfully affects outcomes when both treatment arms receive the same evidence-based physiotherapy program. Oral NSAIDs remain common in everyday care, particularly in low- and middle-income settings, because they are familiar, inexpensive, and readily available. However, their adverse-effect profile makes them less attractive for repeated use in chronic disorders. Topical NSAIDs, by contrast, may offer a more favorable risk-benefit balance, yet they remain underused in many rehabilitation settings because clinicians often perceive them as less potent or because comparative evidence in CLBP is sparse. High-quality head-to-head trials evaluating oral and topical NSAIDs within the same structured exercise protocol are therefore clinically necessary to guide safer prescribing without compromising symptomatic improvement (18-20).

This question is particularly relevant in Pakistan and similar healthcare environments, where chronic low back pain is common, access to comprehensive rehabilitation may be inconsistent, and pharmacological treatment is often emphasized more heavily than structured physiotherapy. In such contexts, identifying a treatment combination that is effective, practical, and associated with fewer adverse events could meaningfully improve patient care. A strategy that preserves pain and disability reduction while lowering systemic risk would have implications not only for clinicians and patients but also for health systems seeking scalable and safer approaches to chronic musculoskeletal management (17,18,21).

Against this background, the present trial was designed to compare the effectiveness and safety of oral versus topical NSAIDs when each was combined with a standardized lumbar stabilization exercise program in individuals with non-specific chronic low back pain. The study specifically evaluated changes in pain intensity and functional disability over six weeks and simultaneously examined adverse-event profiles to support a more balanced assessment of therapeutic value. We hypothesized that topical NSAIDs would provide pain and disability outcomes comparable to oral NSAIDs while demonstrating superior tolerability, thereby representing a safer adjunct to multimodal rehabilitation in CLBP (7,10,14,22).

MATERIALS AND METHODS

This study was conducted as a prospective, parallel-group, assessor-blinded randomized controlled trial with a 1:1 allocation ratio over a six-week intervention period in the outpatient physiotherapy departments of tertiary care hospitals and rehabilitation centers in Pakistan. The trial compared two multimodal treatment strategies for non-specific chronic low back pain, namely oral NSAIDs combined with lumbar stabilization exercises and topical NSAIDs combined with the same exercise program. The design was selected to permit direct comparison of efficacy and safety between routes of NSAID administration while holding the physiotherapy component constant across groups. Recruitment, baseline assessment, allocation, intervention delivery, and follow-up were performed in a sequential manner according to a predefined study workflow, and all participants provided written informed consent before enrollment.

Adults aged 18 to 60 years with non-specific chronic low back pain of more than 12 weeks' duration and a baseline Numeric Pain Rating Scale score of at least 4 were considered eligible for participation. Participants were additionally required to be able to understand and follow exercise instructions and to consent voluntarily to trial participation. Individuals were excluded if they had specific spinal pathology such as tumor, infection, or fracture, lumbar radiculopathy or neurological deficit, previous spinal surgery, inflammatory rheumatic disease, pregnancy, known hypersensitivity or contraindication to NSAIDs, or concurrent use of corticosteroids or opioid analgesics. Eligibility screening was performed before randomization to ensure clinical homogeneity and to reduce confounding from serious spinal disease, competing analgesic exposure, or conditions that could alter treatment safety or response.

Sample size was estimated a priori using a power-based approach for between-group comparison of change in pain intensity. The calculation assumed a moderate effect size of 0.60, a two-tailed alpha of 0.05, and statistical power of 80%, which yielded a minimum requirement of 45 participants per group. To preserve adequate power after expected attrition, the target sample was increased to 100 participants overall, with 50 participants allocated to each arm. This inflation accounted for an anticipated dropout rate of approximately 10% to 15% and was intended to maintain stable estimates for repeated outcome assessment across the study period.

After baseline assessment, eligible participants were assigned to one of the two study groups using a computer-generated randomization sequence prepared independently of recruitment and outcome assessment. Block randomization with variable block sizes of four and six was used to maintain balance between groups throughout enrollment while reducing allocation predictability. Allocation concealment

was implemented through sequentially numbered, opaque, sealed envelopes prepared by an independent researcher who was not involved in participant recruitment, treatment administration, or assessment. Envelopes were opened only after completion of baseline procedures and confirmation of eligibility, thereby minimizing selection bias during assignment. Outcome assessors remained blinded to group allocation throughout follow-up, and data analysis was undertaken without involvement in treatment delivery. Because of the obvious differences between oral and topical drug administration, participants and treating physiotherapists could not be blinded.

Participants allocated to Group A received oral NSAIDs in the form of either ibuprofen 400 mg three times daily or diclofenac 50 mg twice daily, according to physician prescription and individual tolerance, with the selected oral regimen kept consistent for each participant throughout the intervention period. They were instructed to take the medication after meals to reduce gastrointestinal irritation. Participants in Group B received topical diclofenac gel 1%, applied three to four times daily over the lumbar region for the same six-week duration. They were instructed to apply the gel gently to the affected area and to avoid occlusive dressings. Apart from the route of NSAID administration, both groups were managed identically with respect to the physiotherapy program, assessment schedule, and follow-up duration.

All participants underwent a standardized lumbar stabilization exercise program supervised by licensed physiotherapists three times weekly, supplemented by a daily home program. The rehabilitation protocol was progressive and phase-based. During weeks 1 and 2, the activation phase focused on transversus abdominis activation through abdominal hollowing, multifidus activation, pelvic tilts, and static isometric contractions to facilitate neuromuscular control and motor relearning. During weeks 3 and 4, the endurance and control phase incorporated bridging, quadruped bird-dog exercise, dead bug variations, and supine marching to enhance low-load endurance and coordination. During weeks 5 and 6, the functional integration phase advanced to dynamic stabilization, plank progressions, functional lifting activities, and balance training to improve functional strength and real-life movement capacity. Progression across phases was determined by pain-free performance, correct exercise technique, and therapist-supervised readiness to advance, thereby standardizing treatment escalation while protecting participant safety.

The primary outcome was pain intensity measured on the Numeric Pain Rating Scale, a 0-to-10 scale on which higher scores represent greater pain severity. Secondary outcomes included functional disability assessed with the Oswestry Disability Index and treatment-related adverse effects documented using a structured checklist. Gastrointestinal discomfort and epigastric pain were specifically monitored in the oral NSAID arm, while localized skin irritation was monitored in the topical NSAID arm. Baseline measurements were obtained before randomization. Follow-up assessments of pain and adverse events were conducted at baseline, week 2, week 4, and week 6, whereas disability was assessed at baseline, week 4, and week 6. All observations were entered into standardized case report forms by blinded assessors to maintain uniformity of measurement and documentation.

The study variables were operationalized before analysis. Group allocation served as the principal independent variable and was categorized as oral NSAIDs plus lumbar stabilization or topical NSAIDs plus lumbar stabilization. Time was treated as a repeated within-subject factor corresponding to the scheduled assessment points. Continuous dependent variables included pain intensity and disability scores, while categorical safety outcomes included the presence or absence of any adverse event and the type of adverse event recorded. Baseline demographic and clinical characteristics, including age, sex, and duration of chronic low back pain, were documented to evaluate comparability between the two randomized groups and to identify any imbalances that could plausibly influence outcome interpretation.

Several procedural features were incorporated to reduce bias and strengthen internal validity. Randomization and concealed allocation were used to minimize selection bias, blinded outcome assessment was used to reduce detection bias, eligibility restrictions were applied to limit confounding

from specific spinal pathology and competing analgesic exposure, and both groups received an identical physiotherapy protocol to ensure that route of NSAID administration remained the principal treatment contrast. Standardized case report forms, predefined assessment intervals, therapist-guided progression criteria, and a fixed overall treatment duration were used to promote reproducibility and data consistency. All analyses were planned according to the intention-to-treat principle, and sensitivity analysis was undertaken to confirm agreement with the per-protocol findings reported in the study results.

Data were analyzed using SPSS version 26.0. Continuous variables were summarized as mean with standard deviation, whereas categorical variables were presented as frequencies and percentages. Distributional assumptions were evaluated using the Shapiro-Wilk test. Baseline between-group comparisons were performed using the independent-samples t test for normally distributed continuous variables and the Mann-Whitney U test where distributional assumptions were not met. Longitudinal changes in pain intensity and disability were evaluated using a mixed repeated-measures analysis of variance to assess the effects of time, group, and group-by-time interaction. Effect size was expressed as partial eta squared where appropriate. Categorical adverse events were compared between groups using inferential testing as reported in the results. Statistical significance was set at $p < 0.05$ for all analyses.

Ethical approval was obtained from the relevant institutional review board before commencement of the study. Written informed consent was obtained from all participants, confidentiality and anonymity were maintained throughout data handling and reporting, and participants retained the right to withdraw at any stage without penalty or effect on their care. The trial was conducted in accordance with accepted ethical principles for human research.

RESULTS

A total of 128 individuals were screened for eligibility, of whom 100 met the inclusion criteria and underwent random allocation in a 1:1 ratio to oral NSAIDs plus lumbar stabilization exercises (Group A, n=50) or topical NSAIDs plus lumbar stabilization exercises (Group B, n=50). During the six-week follow-up, 4 participants in Group A and 3 in Group B were lost to follow-up because of non-compliance or personal reasons, resulting in 46 and 47 completers, respectively, and an overall retention rate of 93%. Despite these losses, the analysis was performed according to the intention-to-treat principle, and the manuscript notes that sensitivity analysis remained consistent with the per-protocol findings. Baseline comparability between the groups was preserved, with no statistically significant differences in age, sex distribution, duration of chronic low back pain, baseline pain intensity, or baseline disability, supporting successful randomization and minimizing the likelihood that subsequent group differences were attributable to initial imbalance.

Table 1. Baseline Characteristics of Participants

Variable	Group A (n=50) Mean ± SD / n	Group B (n=50) Mean ± SD / n	Between-Group Difference	p-value
Age (years)	38.4 ± 9.2	37.6 ± 8.8	0.8 years	0.64
Gender (Male/Female)	28 / 22	27 / 23	—	0.84
Duration of CLBP (months)	14.3 ± 6.5	13.9 ± 6.1	0.4 months	0.71
Baseline NPRS	6.92 ± 1.31	6.78 ± 1.42	0.14	0.58
Baseline ODI (%)	42.6 ± 8.9	41.8 ± 9.1	0.8 points	0.66

The mean age differed by only 0.8 years between groups (38.4 ± 9.2 vs 37.6 ± 8.8 years, p=0.64), while chronic low back pain duration was similarly matched (14.3 ± 6.5 vs 13.9 ± 6.1 months, p=0.71). Baseline pain intensity was high and nearly identical in both groups, with NPRS scores of 6.92 ± 1.31 in the oral NSAID group and 6.78 ± 1.42 in the topical NSAID group (p=0.58). Functional disability was likewise comparable at study entry, with ODI values of 42.6 ± 8.9 and 41.8 ± 9.1, respectively (p=0.66). These data indicate a well-balanced randomized sample.

Pain intensity declined significantly over time in both treatment groups. Mixed ANOVA demonstrated a strong main effect of time for NPRS scores, with $F(3,276)=182.4$, $p<0.001$, and partial $\eta^2=0.664$, indicating that approximately 66.4% of the explained variance in pain scores was attributable to temporal change across follow-up. By contrast, the main effect of group was not statistically significant, $F(1,92)=2.94$, $p=0.089$, partial $\eta^2=0.031$, and the group-by-time interaction was also not significant, $F(3,276)=1.87$, $p=0.134$. These findings indicate that both interventions produced meaningful pain reduction, but neither strategy demonstrated superiority over the other in the rate or extent of improvement across the six-week period.

Table 2. Change in Pain Intensity Over Time (Numeric Pain Rating Scale)

Time Point	Group A Mean ± SD	Group B Mean ± SD	Mean Difference (95% CI)	p-value
Baseline	6.92 ± 1.31	6.78 ± 1.42	0.14 (−0.39 to 0.67)	0.58
Week 2	5.21 ± 1.18	5.36 ± 1.27	−0.15 (−0.62 to 0.32)	0.52
Week 4	3.98 ± 1.09	4.15 ± 1.16	−0.17 (−0.60 to 0.26)	0.44
Week 6	2.71 ± 0.96	2.94 ± 1.02	−0.23 (−0.64 to 0.18)	0.089

Both groups achieved clinically important pain reduction from baseline to week 6. In Group A, mean NPRS decreased from 6.92 to 2.71, an absolute reduction of 4.21 points and a relative reduction of approximately 60.8%. In Group B, the mean NPRS decreased from 6.78 to 2.94, corresponding to an absolute reduction of 3.84 points and a relative reduction of approximately 56.6%. Although the oral NSAID group showed numerically lower pain scores at each follow-up after week 2, the between-group mean differences remained small, ranging from −0.15 to −0.23 points, and all 95% confidence intervals crossed zero, indicating statistical non-significance at every comparison point. Importantly, the magnitude of improvement in both groups exceeded the stated minimal clinically important difference threshold of at least 2 NPRS points.

Responder analysis further supported the similarity of treatment efficacy. At week 6, 36 of 50 participants in Group A (72%) and 34 of 50 in Group B (68%) achieved at least 50% pain reduction from baseline. The relative risk was 1.06 with a 95% confidence interval of 0.84 to 1.32 and a p-value of 0.61, confirming that the proportion of clinically meaningful responders was comparable between interventions. This indicates that topical NSAIDs did not materially underperform relative to oral NSAIDs in achieving substantial symptomatic relief.

Table 3. Responder Analysis at Week 6

Outcome	Group A n (%)	Group B n (%)	Relative Risk (95% CI)	p-value
≥50% pain reduction	36 (72%)	34 (68%)	1.06 (0.84–1.32)	0.61

Functional disability also improved significantly over time in both groups. Mixed ANOVA for ODI demonstrated a strong time effect, $F(2,184)=156.7$, $p<0.001$, partial $\eta^2=0.630$, indicating that 63.0% of the explained variance in disability scores was associated with temporal improvement. The group effect was not significant, $F(1,92)=2.56$, $p=0.11$, and no significant group-by-time interaction was observed ($p=0.142$). These findings parallel the NPRS results and suggest that the route of NSAID administration did not significantly alter the disability trajectory when paired with the same lumbar stabilization program.

Table 4. Change in Functional Disability Over Time (Oswestry Disability Index)

Time Point	Group A Mean ± SD	Group B Mean ± SD	Mean Difference (95% CI)	p-value
Baseline	42.6 ± 8.9	41.8 ± 9.1	0.8 (−3.1 to 4.7)	0.66
Week 4	31.2 ± 7.5	32.4 ± 7.8	−1.2 (−4.5 to 2.1)	0.48
Week 6	22.8 ± 6.3	24.6 ± 6.9	−1.8 (−4.8 to 1.2)	0.11

From baseline to week 6, Group A improved from an ODI score of 42.6 to 22.8, representing an absolute decrease of 19.8 points and a relative reduction of approximately 46.5%. Group B improved from 41.8 to 24.6, reflecting an absolute decrease of 17.2 points and a relative reduction of approximately 41.1%. The week-6 between-group mean difference was −1.8 points (95% CI, −4.8 to 1.2; $p=0.11$), again favoring Group A numerically but without statistical significance. The absolute ODI reductions in both groups exceeded 15 points, indicating substantial functional benefit in each intervention arm.

The safety analysis demonstrated the principal between-group distinction observed in the trial. Any adverse event occurred in 19 of 50 participants in Group A (38%) compared with 11 of 50 participants in Group B (22%), yielding a relative risk of 1.72 (95% CI, 1.01 to 2.92; p=0.041). Gastrointestinal discomfort was more frequent in the oral NSAID group than in the topical group, affecting 22% versus 4% of participants, while epigastric pain occurred in 14% versus 2%, respectively. In contrast, mild skin irritation occurred more commonly in the topical NSAID group, although absolute numbers remained low. The overall chi-square test for adverse events was statistically significant (χ^2=9.84, p=0.002), supporting a clinically important safety advantage for topical NSAIDs despite comparable efficacy outcomes.

Table 5. Adverse Events During the Six-Week Intervention

Adverse Event	Group A n (%)	Group B n (%)	Relative Risk (95% CI)	p-value
Any adverse event	19 (38%)	11 (22%)	1.72 (1.01–2.92)	0.041
Gastrointestinal discomfort	11 (22%)	2 (4%)	5.5 (1.3–22.8)	<0.01
Epigastric pain	7 (14%)	1 (2%)	7.0 (0.9–53.4)	<0.05
Skin irritation	1 (2%)	5 (10%)	0.2 (0.02–1.6)	<0.05

Taken together, the results indicate that both oral and topical NSAIDs, when combined with lumbar stabilization exercises, produced marked and clinically relevant reductions in pain and disability over six weeks. The efficacy profiles were statistically comparable across all major therapeutic endpoints, including responder status, while the safety profile clearly favored topical NSAIDs because of lower systemic adverse-event burden. This pattern supports the interpretation that topical NSAIDs may preserve therapeutic benefit while offering a more favorable risk profile in multimodal chronic low back pain rehabilitation.

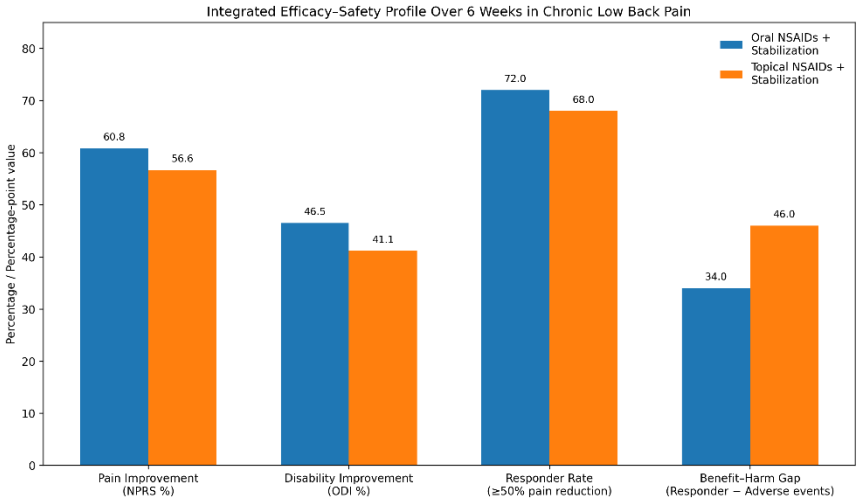

Figure 1 Integrated Efficacy Safety Profile Over 6 Weeks

This figure shows that the oral NSAID group achieved slightly greater relative improvement in pain (60.8% vs 56.6%) and disability (46.5% vs 41.1%), but the difference in responder frequency was small (72% vs 68%), whereas the safety contrast was more pronounced, with adverse events occurring in 38% of oral NSAID users compared with 22% of topical NSAID users. As a result, the derived benefit-to-harm gap, defined as responder rate minus overall adverse-event rate, favored topical NSAIDs by 12 percentage points (46 vs 34), suggesting that the clinical tradeoff was driven less by efficacy separation and more by reduced treatment-related harm in the topical group.

DISCUSSION

The present randomized controlled trial compared oral and topical NSAIDs as adjuncts to a standardized lumbar stabilization program in individuals with non-specific chronic low back pain and found that both treatment strategies produced substantial and clinically meaningful reductions in pain intensity and

functional disability over six weeks. The mixed-model analyses demonstrated strong time effects for both NPRS and ODI outcomes, with partial eta squared values of 0.664 and 0.630, respectively, indicating that the principal therapeutic change across follow-up was attributable to improvement over time rather than a differential effect of treatment route. Although the oral NSAID group showed slightly greater numerical reduction in pain and disability at week 6, the between-group differences were small, all confidence intervals crossed zero, and neither the main group effect nor the interaction effect reached statistical significance. These findings indicate that topical NSAIDs achieved clinical outcomes comparable to oral NSAIDs when both were integrated with a structured exercise-based rehabilitation program.

The magnitude of symptomatic improvement observed in both groups is clinically notable. Mean NPRS reduction reached 4.21 points in the oral NSAID group and 3.84 points in the topical NSAID group, exceeding the minimal clinically important difference threshold described in the manuscript. Similarly, ODI scores improved by 19.8 points and 17.2 points, respectively, reflecting substantial functional recovery over a relatively short intervention period. These results suggest that the combined treatment model was effective in addressing both symptomatic and disability-related aspects of chronic low back pain. The findings are also consistent with the broader literature indicating that multimodal management, particularly when exercise therapy is used as a central strategy, offers more meaningful and sustainable benefit than isolated passive interventions alone (14,15,17,26,27).

A central interpretation of the trial is that the route of NSAID administration did not materially alter short-term rehabilitation outcomes when the same lumbar stabilization program was applied to both groups. This is important because the exercise intervention likely served as a major therapeutic driver. Lumbar stabilization exercises are designed to improve deep trunk muscle recruitment, segmental spinal control, and coordinated functional movement, thereby targeting biomechanical and neuromuscular impairments implicated in chronic low back pain persistence. The large time effects found in this trial support the view that structured stabilization exercise contributed substantially to the observed gains, while NSAIDs may have functioned primarily as adjunctive agents that reduced pain sufficiently to improve participation and tolerance during rehabilitation. This interpretation aligns with prior evidence supporting exercise therapy and motor control approaches in chronic non-specific low back pain (14-17).

The responder analysis further strengthens the conclusion of comparable efficacy. At week 6, 72% of participants in the oral NSAID group and 68% in the topical NSAID group achieved at least 50% reduction in pain, with a relative risk of 1.06 and a non-significant p-value of 0.61. From a clinical perspective, this indicates that a similar proportion of patients in each group experienced substantial improvement rather than merely modest average change. Because responder-based outcomes often reflect treatment benefit more intuitively than group means alone, this result increases confidence that topical NSAIDs did not underperform meaningfully in practical terms. In settings where safety and tolerability influence adherence and prescribing decisions, such equivalence in clinically important response is highly relevant (10,22,28).

The most important between-group distinction in the trial was safety. Overall adverse events occurred in 38% of participants treated with oral NSAIDs compared with 22% of those treated with topical NSAIDs, corresponding to a relative risk of 1.72. Gastrointestinal discomfort and epigastric pain were markedly more common in the oral NSAID group, whereas adverse events in the topical NSAID group were largely limited to mild localized skin irritation. This pattern is consistent with the established pharmacological rationale for topical delivery, which allows high local tissue exposure with lower systemic absorption and consequently a reduced risk of systemic toxicity. In chronic musculoskeletal conditions, where repeated dosing or extended use is common, the cumulative burden of adverse effects becomes an important determinant of therapeutic suitability. The present findings therefore support the

view that topical NSAIDs may achieve a more favorable benefit-risk balance than oral NSAIDs in multimodal rehabilitation for chronic low back pain (8,10,19,22,24,25,28,29).

These findings have direct implications for patient-centered care. When two treatment strategies offer broadly similar improvement in pain and function, the approach with the lower systemic adverse-event burden becomes more attractive, particularly for individuals who may be vulnerable to gastrointestinal, renal, or cardiovascular complications. This is especially pertinent in patients requiring repeated or prolonged symptom control during rehabilitation. Although the present trial evaluated only a six-week period, even within this short duration the oral NSAID group demonstrated a clearly less favorable tolerability profile. Clinicians managing chronic low back pain may therefore reasonably consider topical NSAIDs as the preferred pharmacological adjunct when exercise-based rehabilitation is already in place and when the therapeutic goal is to support participation without unnecessarily increasing systemic risk (5,7,8,19,26).

The trial also carries contextual importance for practice in Pakistan and similar resource-constrained environments. In many such settings, oral NSAIDs are routinely used because they are inexpensive, familiar, and widely available, while structured physiotherapy is less consistently implemented. The current findings suggest that combining evidence-based lumbar stabilization with topical NSAIDs may provide a practical alternative capable of preserving clinical efficacy while improving safety. This is relevant not only for individual treatment decisions but also for rehabilitation service design and prescribing culture. A multimodal model that places exercise at the core of management and uses lower-risk pharmacological support may help reduce overreliance on systemic medication while improving functional outcomes in routine care (16-18,30).

Several limitations should be considered when interpreting these findings. First, the intervention period was restricted to six weeks, so the durability of treatment effects, recurrence prevention, and longer-term safety cannot be determined from the current dataset. Second, because participants and therapists could not be blinded to treatment route, some performance bias may have been introduced despite blinded outcome assessment. Third, the oral NSAID arm included two drugs, ibuprofen and diclofenac, which may have introduced some heterogeneity in response or tolerability. Fourth, the absence of an exercise-only control arm limits the ability to isolate the independent contribution of NSAID therapy beyond the shared rehabilitation effect. Finally, psychosocial variables known to influence chronic pain outcomes were not measured, which restricts interpretation of whether baseline pain beliefs, fear, or emotional distress modified response to treatment. These limitations do not invalidate the results, but they do indicate that the findings should be generalized with appropriate caution.

Future research should extend follow-up duration, standardize the oral comparator more tightly, and examine whether the comparative advantage of topical NSAIDs persists over longer rehabilitation periods or in subgroups with differing baseline risk profiles. Trials incorporating quality-of-life outcomes, treatment satisfaction, exercise adherence, and formal cost-effectiveness evaluation would also strengthen decision-making relevance. In addition, multicenter designs and broader sampling frames would improve external validity and help determine whether the present results remain stable across other care settings and patient populations. Such work would be particularly valuable in informing clinical guidelines that must balance efficacy, safety, feasibility, and affordability in the management of chronic low back pain (18,19,26,28).

CONCLUSION

This randomized controlled trial demonstrated that oral and topical NSAIDs, when combined with a structured lumbar stabilization exercise program, both produced substantial and clinically meaningful improvements in pain intensity and functional disability in individuals with chronic low back pain over six weeks. Although efficacy outcomes were statistically comparable between groups, topical NSAIDs showed a clearly superior safety profile, with fewer overall adverse events and markedly lower

gastrointestinal complications. These findings support topical NSAIDs as a viable and potentially preferable pharmacological adjunct within multimodal rehabilitation for chronic low back pain, particularly when clinicians seek to preserve therapeutic benefit while minimizing systemic treatment-related harm.

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