Comparative Effects of Modified Yogasana and Prop-Assisted Yogasana on Pain, Disability, and C-Reactive Protein in Adults with Mechanical Low Back Pain

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Abstract—**Background: Chronic mechanical low back pain is associated with persistent pain, functional disability, and reduced participation in daily activities. Modified and prop-assisted Yogasana may provide different levels of active movement and external support, however, comparative evidence remains limited.**
Objective: To compare the effects of modified Yogasana and prop-assisted Yogasana on pain intensity, back-related disability, and serum C-reactive protein (CRP) in men with chronic mechanical low back pain.
Methods: This non-randomized controlled study included 90 men aged 35–45 years who were assigned to a Modified Yogasana Group, Prop-Assisted Yogasana Group, or medication-only Control Group, with 30 participants in each group. Both Yogasana interventions were administered for 12 weeks, five sessions per week, for 60 minutes per session. Pain intensity, Oswestry Disability Index scores, and serum CRP were assessed at pretest, mid-test, and post-test. Data were analysed using one-way analysis of variance and Scheffé's post-hoc test, with significance established at $p < 0.05$.
Results: Baseline pain and disability did not differ significantly among the groups. At post-test, pain scores were significantly lower in the Modified Yogasana Group (3.25 ± 0.71) and Prop-Assisted Yogasana Group (3.82 ± 0.89) than in the Control Group (7.07 ± 0.76, $F = 205.10$, $p < 0.05$). Modified Yogasana also produced a significantly lower pain score than prop-assisted Yogasana. Post-test disability scores were 23.96 ± 4.18, 26.09 ± 5.33, and 44.13 ± 4.56, respectively ($F = 165.67$, $p < 0.05$). Both Yogasana groups differed significantly from the Control Group, whereas the difference between the two Yogasana groups was not significant. Post-test CRP values were 3.09 ± 0.88, 4.38 ± 0.79, and 6.50 ± 1.05 mg/L, respectively ($F = 106.49$, $p < 0.05$). However, CRP differed significantly among the groups at baseline.
Conclusion: Both modified and prop-assisted Yogasana were associated with reduced pain and disability compared with medication alone. Modified Yogasana produced a greater reduction in pain, while both interventions demonstrated comparable improvements in disability. The CRP findings require cautious interpretation and confirmation through baseline-adjusted analysis because of the significant pre-intervention imbalance.

Index Terms—**Modified Yogasana, prop-assisted Yogasana, chronic mechanical low back pain, pain intensity, Oswestry Disability Index, C-reactive protein**

I. Introduction

Low back pain is a major musculoskeletal health problem and a leading contributor to disability worldwide. It is commonly associated with persistent pain, activity limitations, reduced work capacity, and restricted participation in everyday life. Low back pain is heterogeneous and may arise from specific pathological conditions or occur without a clearly identifiable structural cause. Mechanical low back pain is generally

characterized by symptoms that vary in response to posture, movement, physical loading, or activity. When symptoms persist for 12 weeks or longer, the condition is commonly classified as chronic mechanical low back pain. Current clinical guidance recommends person-centred, non-surgical management incorporating education, structured exercise, and other interventions appropriate to the individual's clinical presentation and needs (World Health Organization, 2023).

Pain intensity and back-related disability are related but distinct clinical outcomes. Pain intensity reflects the individual's perceived severity of symptoms, whereas disability represents the extent to which low back pain interferes with mobility, self-care, occupational activities, and social participation. Persistent pain is a multidimensional experience influenced by biological, psychological, behavioural, and contextual factors and does not necessarily correspond directly to the degree of tissue damage (Pearson, 2008). The simultaneous assessment of pain and disability may therefore provide a broader understanding of clinical and functional changes than the assessment of pain alone.

Exercise-based interventions are commonly recommended as part of the non-surgical management of chronic low back pain. Yoga is a mind–body practice that may integrate physical postures, controlled movement, breathing regulation, relaxation, and attentional awareness. Previous controlled studies have reported improvements in pain and back-related function following structured yoga programmes among adults with chronic low back pain (Williams et al., 2005; Sherman et al., 2005; Tilbrook et al., 2011). Nevertheless, the certainty of the available evidence varies, and yoga has not consistently demonstrated superiority over other forms of structured exercise. Yoga interventions for individuals with low back pain should therefore be appropriately selected, progressively delivered, carefully supervised, and accompanied by systematic monitoring of adherence and adverse events.

The therapeutic application of Yogasana differs from the uniform performance of standardized postures. Modified Yogasana may involve altering the starting position, range of movement, duration, repetition, or complexity of a posture according to the individual's pain, mobility, strength, balance, and functional capacity. Ananthanarayanan and Srinivasan described an asana-based approach in which practices were selected and progressively graded according to their biomechanical demands and the participant's functional ability. Foulkes (2017) similarly characterized yoga therapy as an adaptive and person-centred process in which practices are modified to support agreed therapeutic objectives. These approaches provide a rationale for gradual progression and individualized Yogasana practice in people with chronic low back pain.

Prop-assisted Yogasana represents a related but distinct approach in which external supports, such as chairs, belts, blocks, bolsters, blankets, ropes, or wall support, are incorporated into posture performance. Williams, Steinberg, and Petronis (2003) described the therapeutic application of Iyengar Yoga for chronic low back pain and emphasized the use of props to facilitate positioning, support selected postures, and adjust their physical demands. Pearson (2008) also identified props, slow repetitions, and gradual increases in movement as potential strategies for adapting Yogasana practice for individuals experiencing persistent pain. However, these proposed benefits should not be interpreted as evidence that prop-assisted Yogasana is inherently safer or more effective than modified Yogasana without external support.

Although modified and prop-assisted Yogasana are both intended to make practice accessible and responsive to individual needs, they may influence posture performance differently. Modified Yogasana may primarily emphasize active control within an adjusted range of movement, whereas prop-assisted Yogasana may provide additional external support, positioning assistance, or load modification. Direct evidence comparing these two approaches in adults with chronic mechanical low back pain remains limited. A

comparative investigation may therefore help determine whether their effects on pain and back-related disability differ from each other and from those observed in a control group.

Chronic low back pain is commonly examined from biomechanical, functional, and psychosocial perspectives; however, inflammatory processes may also be relevant in certain clinical subgroups. C-reactive protein (CRP) is a non-specific systemic marker of inflammation. Previous research has reported possible associations between CRP and some presentations of non-specific low back pain, although the findings are heterogeneous and do not establish CRP as a diagnostic marker, direct cause, or biological mediator of mechanical low back pain. CRP concentrations may also be influenced by infection, body mass index, smoking, metabolic disorders, inflammatory diseases, medication use, recent injury, and strenuous physical activity. These factors must therefore be considered when assessing and interpreting changes in CRP.

Previous yoga studies involving chronic low back pain have predominantly examined patient-reported outcomes such as pain and disability. Evidence concerning changes in CRP following modified or prop-assisted Yogasana interventions remains comparatively limited. Evaluating pain, disability, and CRP together may provide preliminary information regarding whether clinical, functional, and inflammatory changes occur during the same intervention period. Nevertheless, simultaneous changes in these outcomes would not demonstrate that CRP mediated improvements in pain or disability.

Accordingly, the present non-randomized controlled study aimed to compare the effects of modified Yogasana and prop-assisted Yogasana on pain intensity, back-related disability, and CRP among men aged 35–45 years with chronic mechanical low back pain. Participants were assigned to a modified Yogasana group, a prop-assisted Yogasana group, or a medication-only control group. It was hypothesized that both Yogasana interventions would produce greater improvements in pain and disability than the control condition. The comparison of CRP changes was undertaken to examine the possible systemic inflammatory response associated with the interventions. Because group allocation was non-randomized and CRP is a non-specific biomarker, the findings require cautious interpretation with consideration of baseline differences, medication use, adherence, co-interventions, and other potential confounding factors.

Aim of the Study

To compare the effects of modified Yogasana and prop-assisted Yogasana on pain intensity, back-related disability, and C-reactive protein levels in men aged 35–45 years with chronic mechanical low back pain.

Primary Objectives

1. To assess changes in pain intensity following a 12-week modified Yogasana intervention among men with chronic mechanical low back pain.
2. To assess changes in pain intensity following a 12-week prop-assisted Yogasana intervention among men with chronic mechanical low back pain.
3. To compare the changes in pain intensity among the modified Yogasana, prop-assisted Yogasana, and medication-only control groups.
4. To assess changes in back-related disability following modified Yogasana and prop-assisted Yogasana interventions.
5. To compare the changes in back-related disability among the three study groups.

Secondary Objective

6. To assess and compare changes in C-reactive protein levels among the modified Yogasana, prop-assisted Yogasana, and medication-only control groups.

Additional Comparative Objective

7. To determine whether modified Yogasana or prop-assisted Yogasana produces greater improvement in pain, disability, and C-reactive protein compared with the medication-only control condition.

Justification of the Study

Chronic mechanical low back pain is a common musculoskeletal condition that can cause persistent pain, functional limitations, reduced work capacity, and difficulty performing activities of daily living. Although medications may provide symptomatic relief, pharmacological treatment alone may not adequately address impaired movement, reduced physical function, fear of movement, or other factors associated with persistent disability. Consequently, there is a need to examine safe and structured non-pharmacological interventions that can complement conventional management.

Yoga-based interventions have demonstrated potential benefits for pain and functional disability in individuals with chronic low back pain. However, Yogasana programmes differ considerably in posture selection, intensity, progression, supervision, and the use of external supports. Conventional postures may also be difficult for individuals with pain, restricted mobility, reduced balance, or limited functional capacity.

Modified Yogasana adapts the starting position, range of movement, duration, repetition, or complexity of selected postures according to the participant's functional ability. Prop-assisted Yogasana uses chairs, bolsters, ropes, walls, or other external supports to facilitate positioning and modify the physical demands of the posture. Although both approaches are intended to improve accessibility and support individual participation, they should not be assumed to produce identical clinical outcomes.

Direct comparative evidence examining modified Yogasana and prop-assisted Yogasana in adults with chronic mechanical low back pain remains limited. Comparing these approaches with a medication-only control group may provide useful information regarding their relative associations with changes in pain and back-related disability. Such evidence may assist yoga therapists, rehabilitation professionals, and healthcare practitioners in selecting an appropriate Yogasana approach according to the participant's physical capacity and therapeutic requirements.

Pain and disability are primarily patient-reported outcomes. The inclusion of C-reactive protein provides an additional objective biochemical measure of systemic inflammation. However, CRP is a non-specific biomarker and may be influenced by infection, obesity, smoking, medication use, metabolic disorders, inflammatory diseases, and recent physical activity. Therefore, CRP findings must be interpreted cautiously and should not be considered evidence that mechanical low back pain is directly caused by systemic inflammation.

The present study is justified because it evaluates three complementary dimensions of chronic mechanical low back pain: perceived pain, functional disability, and a systemic inflammatory biomarker. By comparing modified Yogasana, prop-assisted Yogasana, and a medication-only control condition, the study may contribute preliminary evidence regarding the relative usefulness of these two Yogasana approaches as adjunctive strategies for managing chronic mechanical low back pain.

Because the study uses non-randomized group allocation, its findings should be interpreted as comparative evidence rather than definitive proof of causation. Baseline differences, medication use, adherence,

co-interventions, body mass index, and other potential confounding factors should be documented and considered during statistical analysis and interpretation.

II. Study Design

2.1 Study Design

The study adopted a three-group, non-randomized controlled pretest–mid-test–post-test design. It was conducted to compare the effects of modified Yogasana and prop-assisted Yogasana on pain intensity, back-related disability, and serum C-reactive protein among men with chronic mechanical low back pain.

2.2 Study Setting

The study was conducted in Chennai, Tamil Nadu, India. Participant screening, intervention delivery, and outcome assessments were undertaken under supervised conditions. Measurements were obtained before the intervention, at the midpoint of the intervention, and after completion of the 12-week study period.

2.3 Participants

A total of 90 male participants aged 35–45 years with clinically diagnosed chronic mechanical low back pain were included. Eligible participants were assigned through a non-random procedure to three groups of 30 participants each:

- Group I: Modified Yogasana group, n = 30;
- Group II: Prop-assisted Yogasana group, n = 30; and
- Group III: Medication-only control group, n = 30.

Participants were clinically evaluated before enrolment to determine eligibility and suitability for participation in the study.

2.4 Operational Definition of Chronic Mechanical Low Back Pain

For this study, chronic mechanical low back pain was defined as pain located between the lower rib margins and the gluteal folds, persisting for at least 12 weeks, and influenced by posture, movement, physical loading, or activity.

Participants with serious or specific causes of low back pain were excluded through clinical screening.

2.5 Eligibility Criteria

2.5.1 Inclusion criteria

Participants were included if they:

- Were male and aged 35–45 years;
- Had clinically diagnosed mechanical low back pain persisting for at least 12 weeks;
- Were medically fit to participate in the assigned Yogasana intervention;
- Were willing to attend five supervised sessions per week for 12 weeks;
- Agreed to complete the pretest, mid-test, and post-test assessments; and
- Provided written informed consent.

2.5.2 Exclusion criteria

Participants were excluded if they had:

- Spinal fracture, tumour, malignancy, or infection;
- Inflammatory spinal disease;
- Severe or progressive neurological impairment;
- Acute intervertebral disc prolapse with significant neurological symptoms;
- A history of spinal surgery;
- Serious cardiovascular, respiratory, neurological, or systemic disease limiting physical activity;
- Acute infection or another inflammatory condition likely to influence CRP;
- Regular participation in another structured yoga or exercise programme;
- Any medical contraindication to the prescribed Yogasana practices; or
- Any condition considered unsafe by the evaluating clinician.

2.6 Intervention Duration and Frequency

The modified Yogasana and prop-assisted Yogasana interventions were administered for 12 weeks. Participants attended five supervised sessions per week, with each session lasting approximately 60 minutes.

Practices were introduced progressively and performed within a comfortable range of movement. Participants were instructed to avoid forceful movements and to report any increase in pain, discomfort, or other adverse symptoms.

2.7 Modified Yogasana Intervention

Participants in Group I received a structured modified Yogasana programme. The starting position, range of movement, number of repetitions, holding duration, and complexity of each practice were adapted according to the participant's pain intensity, mobility, balance, and functional capacity.

The modified Yogasana programme included:

- Makarasana;
- Ardha Supta Pawanamuktasana;
- Adho Mukha Virasana;
- Tadasana;
- Supta Padangusthasana I;
- Marjaryasana–Bitilasana movement;
- Supine spinal twisting; and
- Supta Baddha Konasana.

The practices were performed slowly with coordinated breathing. The range of movement, number of repetitions, and posture-holding duration were progressively increased according to participant tolerance and clinical response.

2.8 Prop-Assisted Yogasana Intervention

Participants in Group II received a structured prop-assisted Yogasana programme. Chairs, bolsters, ropes, and other external supports were used to facilitate positioning and adjust the physical demands of the selected practices.

The prop-assisted Yogasana programme included:

- Chair-supported Savasana;
- Ardha Halasana with chair support;
- Setu Bandha Sarvangasana supported by a bolster;
- Adho Mukha Svanasana using ropes; and
- Seated spinal twisting using a chair.

Prop placement and posture performance were supervised to ensure appropriate positioning and participant safety. The amount of external support, range of movement, and duration of the practices were adjusted according to the participant's functional capacity and response.

2.9 Control Condition

Participants in Group III continued their physician-prescribed medication and did not receive either of the Yogasana interventions during the 12-week study period. They were instructed not to begin another structured yoga or exercise programme during the study.

Medication use and any changes in treatment were documented because analgesic, anti-inflammatory, and other medications could influence pain intensity, disability, and CRP.

2.10 Outcome Assessment

Pain intensity and back-related disability were considered the primary outcomes. Serum C-reactive protein was considered a secondary biochemical outcome.

All outcomes were assessed at the following three time points:

- Pretest: before commencement of the intervention;
- Mid-test: at the midpoint of the 12-week intervention; and
- Post-test: after completion of the 12-week intervention.

2.11 Pain Intensity

Pain intensity was assessed using a 10-cm Visual Analogue Scale. The scale ranged from 0, representing no pain, to 10, representing the worst imaginable pain.

Participants indicated the point that best represented the intensity of their low back pain. Lower scores indicated lower pain intensity.

2.12 Back-Related Disability

Back-related disability was assessed using the Oswestry Disability Index. The instrument evaluates the effect of low back pain on daily activities, including personal care, lifting, walking, sitting, standing, sleeping, social participation, travelling, and occupational or household activities.

The total score was expressed as a percentage ranging from 0% to 100%. Higher scores indicated greater disability, while lower scores indicated improved functional ability.

2.13 C-Reactive Protein

Serum C-reactive protein was measured in milligrams per litre as a non-specific indicator of systemic inflammation. Venous blood samples were collected at the pretest, mid-test, and post-test assessments and analysed using consistent laboratory procedures throughout the study.

Participants were screened for fever, acute infection, recent injury, or another condition likely to influence CRP at the time of blood collection. CRP findings were interpreted cautiously because CRP may also be affected by body mass index, smoking, medication use, metabolic disorders, and other inflammatory conditions.

2.14 Intervention Adherence

Attendance was recorded for every supervised session. Adherence was evaluated using the number of sessions attended during the 12-week intervention.

Participants were instructed to maintain their usual daily activities and to report any additional exercise, treatment, or medication changes during the study period.

2.15 Safety and Adverse-Event Monitoring

Participants were monitored for increased pain, discomfort, injury, dizziness, fatigue, and other adverse responses during the intervention.

When an adverse response occurred, the practice was modified, temporarily suspended, or discontinued according to the participant's clinical condition. All adverse events and withdrawals were documented.

2.16 Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of Vels Institute of Science, Technology and Advanced Studies, Chennai, India.

Participants were informed about the study's purpose, procedures, possible benefits, and potential risks. Written informed consent was obtained before enrolment. Participation was voluntary, and participants were informed of their right to withdraw from the study without penalty.

Participant information was kept confidential throughout data collection, analysis, and publication.

2.17 Statistical Analysis

Data were summarized using means and standard deviations. One-way analysis of variance was used to examine differences among the modified Yogasana, prop-assisted Yogasana, and medication-only control groups at the pretest, mid-test, and post-test assessments.

The calculated F-ratios were compared with the critical F-value at the 0.05 level of significance. When a statistically significant overall group difference was identified, Scheffé's post-hoc test was applied to determine which paired group means differed significantly.

Statistical significance was established at $p < 0.05$. Lower pain and disability scores represented clinical improvement, while lower CRP values indicated lower systemic inflammatory activity. Because CRP differed significantly among the groups at baseline, this baseline imbalance was considered when interpreting the post-intervention CRP findings.

III. Pain Intensity

Table 1 presents the pretest, mid-test, and post-test pain-intensity scores of the Modified Yogasana Group, Prop-Assisted Yogasana Group, and Control Group, together with the results of the one-way analysis of variance.

Test	Group I Modified Yogasana	Group II Prop-Assisted Yogasana	Group III Control	Source of Variance	Sum of Squares	df	Mean Square	F-ratio
Pretest mean	7.97	7.75	7.59					1.33
				Between	2.141	2	1.070	
SD	0.86	1.03	0.78	Within	70.188	87	0.807	
Mid-test mean	5.03	5.51	7.51					70.89*
				Between	103.409	2	51.704	
SD	0.83	0.90	0.83	Within	63.456	87	0.729	
Post-test mean	3.25	3.82	7.07					205.10*
				Between	255.270	2	127.635	
SD	0.71	0.89	0.76	Within	54.139	87	0.622	

*F at the 0.05 level with df (2, 87) = 3.10; *Significant at $p < 0.05$.*

The pretest mean pain-intensity scores of the Modified Yogasana Group, Prop-Assisted Yogasana Group, and Control Group were 7.97, 7.75, and 7.59, respectively. The obtained F-ratio of 1.33 was lower than the critical value of 3.10 and was not statistically significant at the 0.05 level. This finding indicated that the three groups were comparable in pain intensity before commencement of the intervention.

The mid-test mean scores were 5.03 for the Modified Yogasana Group, 5.51 for the Prop-Assisted Yogasana Group, and 7.51 for the Control Group. The obtained F-ratio of 70.89 exceeded the critical value and was statistically significant. Thus, pain intensity differed significantly among the three groups at the mid-intervention assessment.

The post-test mean scores were 3.25, 3.82, and 7.07 for the Modified Yogasana, Prop-Assisted Yogasana, and Control groups, respectively. The obtained F-ratio of 205.10 was statistically significant at the 0.05 level, demonstrating a significant overall difference among the groups after the 12-week intervention.

Scheffé's post-hoc test was applied to identify the paired groups that differed significantly.

Table 2
SCHEFFÉ'S POST-HOC TEST FOR PAIN INTENSITY

Modified Yogasana Group	Prop-Assisted Yogasana Group	Control Group	Mean Difference	Confidence Interval
3.25	3.82	–	0.57*	0.51
3.25	–	7.07	3.82*	0.51
–	3.82	7.07	3.25*	0.51

**Significant at $p < 0.05$.*

The mean difference between the Modified Yogasana and Prop-Assisted Yogasana groups was 0.57, which exceeded the Scheffé confidence-interval value of 0.51. The mean differences between the Modified Yogasana and Control groups and between the Prop-Assisted Yogasana and Control groups were 3.82 and 3.25, respectively. Both values exceeded the required confidence interval.

Therefore, all three pairwise comparisons were statistically significant. Both Yogasana groups had lower post-test pain scores than the Control Group. The Modified Yogasana Group recorded the lowest post-test mean, indicating a greater reduction in pain intensity than the Prop-Assisted Yogasana Group.

3 Back-Related Disability

Table 3 presents the pretest, mid-test, and post-test disability scores of the three groups and the corresponding analysis-of-variance results.

Test	Group I Modified Yogasana	Group II Prop-Assisted Yogasana	Group III Control	Source of Variance	Sum of Squares	df	Mean Square	F-ratio
Pretest mean	49.60	47.07	48.35					1.87
				Between	95.511	2	47.755	
SD	3.92	5.78	5.26	Within	2217.063	87	25.483	
Mid-test mean	33.30	38.39	46.51					49.67*
				Between	2663.063	2	1331.531	
SD	5.62	4.45	5.39	Within	2332.367	87	26.809	

Post-test mean	23.96	26.09	44.13					165.67 *
				Between	7365.527	2	3682.763	
SD	4.18	5.33	4.56	Within	1933.998	87	22.230	

*F at the 0.05 level with df (2, 87) = 3.10; *Significant at p < 0.05.*

The pretest mean disability scores were 49.60 for the Modified Yogasana Group, 47.07 for the Prop-Assisted Yogasana Group, and 48.35 for the Control Group. The obtained F-ratio of 1.87 was lower than the critical value of 3.10 and was not statistically significant. The groups were therefore comparable in back-related disability at baseline.

The mid-test mean disability scores were 33.30, 38.39, and 46.51 for the Modified Yogasana, Prop-Assisted Yogasana, and Control groups, respectively. The obtained F-ratio of 49.67 was statistically significant, indicating an overall difference among the groups at the midpoint of the intervention.

The corresponding post-test mean scores were 23.96, 26.09, and 44.13. The obtained F-ratio of 165.67 exceeded the critical value and was statistically significant at the 0.05 level. Both Yogasana groups recorded lower post-test disability scores than the Control Group.

Scheffé's post-hoc test was used to identify the paired groups responsible for the overall difference.

Table 4 SCHEFFÉ'S POST-HOC TEST FOR BACK-RELATED DISABILITY

Modified Yogasana Group	Prop-Assisted Yogasana Group	Control Group	Mean Difference	Confidence Interval
23.96	26.09	–	2.13	3.03
23.96	–	44.13	20.17*	3.03
–	26.09	44.13	18.04*	3.03

**Significant at p < 0.05.*

The mean difference between the Modified Yogasana and Prop-Assisted Yogasana groups was 2.13, which was lower than the Scheffé confidence-interval value of 3.03. Therefore, the difference between the two Yogasana groups was not statistically significant.

The mean differences between the Modified Yogasana and Control groups and between the Prop-Assisted Yogasana and Control groups were 20.17 and 18.04, respectively. Both values exceeded the required confidence interval and were statistically significant.

These findings indicated that both Yogasana interventions were associated with lower back-related disability than the control condition. Although the Modified Yogasana Group had a numerically lower post-test disability score than the Prop-Assisted Yogasana Group, the difference between the two interventions was not statistically significant.

5 C-Reactive Protein

Table 5 presents the pretest, mid-test, and post-test CRP values of the three groups and the corresponding analysis-of-variance results.

Test	Group I Modified Yogasana	Group II Prop-Assisted Yogasana	Group III Control	Source of Variance	Sum of Squares	df	Mean Square	F-ratio
Pretest mean	6.91	7.39	6.59					4.18*
				Between	9.718	2	4.859	
SD	1.14	1.02	1.07	Within	101.216	87	1.163	
Mid-test mean	5.01	5.51	6.91					21.96*
				Between	58.081	2	29.040	
SD	0.97	1.23	1.23	Within	115.032	87	1.322	
Post-test mean	3.09	4.38	6.50					106.49*
				Between	177.866	2	88.933	
SD	0.88	0.79	1.05	Within	72.658	87	0.835	

*F at the 0.05 level with df (2, 87) = 3.10; *Significant at p < 0.05.*

The pretest mean CRP values were 6.91 mg/L for the Modified Yogasana Group, 7.39 mg/L for the Prop-Assisted Yogasana Group, and 6.59 mg/L for the Control Group. The obtained F-ratio of 4.18 was statistically significant, indicating that the groups were not comparable in CRP at baseline.

The mid-test mean CRP values were 5.01, 5.51, and 6.91 mg/L for the Modified Yogasana, Prop-Assisted Yogasana, and Control groups, respectively. The obtained F-ratio of 21.96 was statistically significant, demonstrating an overall difference among the three groups at the midpoint of the intervention.

The post-test mean CRP values were 3.09, 4.38, and 6.50 mg/L for the Modified Yogasana, Prop-Assisted Yogasana, and Control groups, respectively. The obtained F-ratio of 106.49 was statistically significant at the 0.05 level.

Scheffé's post-hoc test was applied to identify significant pairwise differences in the post-test CRP values.

Table 6 SCHEFFÉ'S POST-HOC TEST FOR C-REACTIVE PROTEIN

Modified Yogasana Group	Prop-Assisted Yogasana Group	Control Group	Mean Difference	Confidence Interval
3.09	4.38	–	1.29*	0.59
3.09	–	6.50	3.41*	0.59
–	4.38	6.50	2.12*	0.59

**Significant at p < 0.05.*

The mean difference between the Modified Yogasana and Prop-Assisted Yogasana groups was 1.29 mg/L, which exceeded the Scheffé confidence-interval value of 0.59 mg/L. The corresponding differences between the Modified Yogasana and Control groups and between the Prop-Assisted Yogasana and Control groups were 3.41 and 2.12 mg/L, respectively. All three pairwise differences were statistically significant.

The Modified Yogasana Group recorded the lowest post-test CRP value, followed by the Prop-Assisted Yogasana Group and Control Group. However, because the groups differed significantly in CRP at baseline, the unadjusted post-test comparison alone does not establish that the intervention caused the observed between-group differences. A baseline-adjusted analysis, such as analysis of covariance, is required to confirm the comparative CRP findings.

3.4 Summary of Findings

The Modified Yogasana and Prop-Assisted Yogasana groups demonstrated lower post-test pain-intensity and disability scores than the medication-only Control Group. Modified Yogasana produced a significantly lower post-test pain score than prop-assisted Yogasana. However, the difference between the two Yogasana groups in back-related disability was not statistically significant.

Post-test CRP values differed significantly among all three groups, with the lowest value observed in the Modified Yogasana Group. Because CRP differed significantly at baseline, the comparative CRP result requires confirmation through baseline-adjusted statistical analysis.

The present study compared the effects of modified Yogasana, prop-assisted Yogasana, and a medication-only control condition on pain intensity, back-related disability, and C-reactive protein in men with chronic mechanical low back pain. The principal findings were that both Yogasana groups demonstrated lower post-intervention pain and disability scores than the Control Group. The Modified Yogasana Group recorded a significantly lower post-test pain score than the Prop-Assisted Yogasana Group, whereas the difference between the two Yogasana groups in disability was not statistically significant. Post-test CRP values also differed among the three groups; however, the interpretation of this outcome is limited by the significant baseline difference in CRP.

IV. Discussion

The significant differences observed between each Yogasana group and the Control Group suggest that participation in a structured Yogasana programme was associated with greater pain reduction than medication alone. This finding is consistent with previous studies reporting improvements in pain following yoga-based interventions for chronic low back pain (Williams et al., 2005; Sherman et al., 2005; Tilbrook et al., 2011). Systematic-review evidence also indicates that yoga may reduce pain in adults with chronic non-specific low back pain, although the certainty of evidence varies and yoga is not consistently superior to other forms of structured exercise.

Several interacting processes may have contributed to the reduction in pain. Slow and controlled movement may improve participants' confidence in movement, reduce protective muscular guarding, and facilitate graded exposure to previously painful activities. Coordinated breathing and attentional regulation may also influence pain perception and reduce excessive physiological arousal. Pearson (2008) emphasized that persistent pain is a multidimensional experience affected by biological, psychological, behavioural, and contextual factors. Consequently, the reduction in pain observed in the present study should not be attributed exclusively to structural or biomechanical changes.

The Modified Yogasana Group demonstrated a significantly lower post-test pain score than the Prop-Assisted Yogasana Group. Modified Yogasana may have required greater active control of movement within an individually adjusted range, potentially encouraging participants to develop movement confidence, muscular coordination, and self-efficacy. Nevertheless, this explanation remains hypothetical because the study did not directly measure movement confidence, muscular activation, fear of movement, or pain self-efficacy.

Prop-assisted Yogasana also produced a substantial reduction in pain. External supports may have helped participants assume selected postures with reduced physical demand and improved positional tolerance. However, the present results do not establish that the use or absence of props independently caused the difference between the two intervention groups. Differences in posture selection, physical loading, active muscular involvement, instructor interaction, adherence, or participant characteristics may also have influenced the outcomes.

4.1 Effects on Pain Intensity

Pain intensity decreased progressively in both intervention groups during the 12-week study. The mean pain score in the Modified Yogasana Group decreased from 7.97 at baseline to 5.03 at the mid-test and 3.25 at the post-test. The Prop-Assisted Yogasana Group demonstrated a reduction from 7.75 to 5.51 and subsequently to 3.82. By comparison, the Control Group demonstrated only a small reduction from 7.59 to 7.07.

4.2 Effects on Back-Related Disability

Back-related disability decreased in both Yogasana groups. The mean disability score in the Modified Yogasana Group decreased from 49.60 at baseline to 33.30 at the mid-test and 23.96 at the post-test. The corresponding score in the Prop-Assisted Yogasana Group decreased from 47.07 to 38.39 and then to 26.09. The Control Group demonstrated a smaller reduction from 48.35 to 44.13.

These findings indicate that both Yogasana interventions were associated with improved functional status compared with the medication-only control condition. Pain reduction alone does not necessarily indicate functional recovery. The concurrent reduction in disability suggests that participants experienced improvements in their ability to perform activities represented by the Oswestry Disability Index, including sitting, standing, walking, lifting, personal care, travelling, and social participation.

The observed findings are consistent with previous research demonstrating that structured yoga programmes can improve back-related function in adults with chronic low back pain. The progressive nature of both interventions may have enabled participants to practise movements at an individually manageable level and gradually increase their functional capacity.

Although the Modified Yogasana Group recorded a numerically lower post-test disability score than the Prop-Assisted Yogasana Group, Scheffé's post-hoc analysis showed that the difference between the two intervention groups was not statistically significant. Therefore, the study does not provide sufficient evidence to conclude that modified Yogasana was superior to prop-assisted Yogasana for reducing disability. Both approaches may be useful for improving functional status, and intervention selection may depend on the participant's pain tolerance, mobility, balance, confidence, and need for external support.

4.3 Effects on C-Reactive Protein

Mean CRP values decreased from 6.91 to 3.09 mg/L in the Modified Yogasana Group and from 7.39 to 4.38 mg/L in the Prop-Assisted Yogasana Group. The Control Group demonstrated comparatively little change, from 6.59 to 6.50 mg/L.

The lower post-test CRP values observed in the two intervention groups may indicate changes in systemic inflammatory activity during the intervention period. CRP is a non-specific acute-phase protein and should not be interpreted as a direct marker of spinal inflammation or as proof of the biological mechanism underlying mechanical low back pain. CRP concentrations may be influenced by infection, adiposity, smoking, metabolic disorders, medication use, recent physical activity, and other inflammatory conditions.

Previous research has reported associations between inflammatory biomarkers and some presentations of non-specific low back pain, but the available evidence is heterogeneous. The present findings may support further investigation of possible relationships among structured physical activity, pain, disability, and systemic inflammatory regulation. They do not establish that the Yogasana interventions directly reduced inflammation or that reduced CRP mediated the improvements in pain and disability.

Importantly, baseline CRP differed significantly among the three groups. The Prop-Assisted Yogasana Group began with the highest mean CRP, while the Control Group began with the lowest value. Therefore, conclusions based solely on unadjusted post-test comparisons may be affected by baseline imbalance and regression to the mean. A baseline-adjusted analysis, such as analysis of covariance, is necessary before making a firm comparative claim regarding the effects of the interventions on CRP.

4.4 Comparison of Modified and Prop-Assisted Yogasana

The findings suggest that both modified and prop-assisted Yogasana may be useful adjunctive approaches for managing chronic mechanical low back pain. Modified Yogasana produced the lowest post-test pain score and a lower post-test disability score than prop-assisted Yogasana. The difference between the two groups was statistically significant for pain but not for disability.

Modified Yogasana may be appropriate for individuals capable of performing actively controlled movements within an adjusted range. Prop-assisted Yogasana may be particularly useful for participants requiring external support, reduced loading, positional assistance, or additional confidence during posture performance. Props should therefore be understood as therapeutic adaptation tools rather than as indicators that an intervention is inherently more or less effective.

The findings support an individualized approach in which the intervention is selected according to the participant's clinical presentation and functional capacity. They do not justify using one standardized programme for every individual with chronic mechanical low back pain.

4.5 Clinical Implications

Structured Yogasana practice may be considered as an adjunct to conventional management for appropriately screened adults with chronic mechanical low back pain. Both interventions were associated with reductions in pain and disability compared with the medication-only condition.

The findings also indicate that external props are not essential for every participant. Individuals with adequate mobility and movement control may benefit from appropriately modified active practices, whereas those with greater pain, reduced mobility, balance limitations, or difficulty maintaining postures may benefit from prop-assisted variations.

Clinical application should include appropriate screening, qualified supervision, progressive practice, monitoring of symptom responses, and documentation of adverse events. Yogasana should not replace necessary medical evaluation or prescribed treatment.

V. Conclusion

The findings of this non-randomized controlled study indicate that both modified Yogasana and prop-assisted Yogasana were associated with reductions in pain intensity and back-related disability among men aged 35–45 years with chronic mechanical low back pain when compared with the medication-only control condition.

Modified Yogasana produced a significantly lower post-test pain score than prop-assisted Yogasana. However, the difference between the two interventions in back-related disability was not statistically significant, suggesting that both approaches may support functional improvement. Although lower post-test C-reactive protein values were observed in both Yogasana groups, the significant baseline difference in CRP prevents a definitive conclusion regarding their comparative effects on systemic inflammation without baseline-adjusted analysis.

Modified and prop-assisted Yogasana may be considered complementary approaches within appropriately supervised, person-centred management of chronic mechanical low back pain. Intervention selection should be based on the individual's pain, mobility, balance, functional capacity, and need for external support. Randomized controlled trials incorporating standardized biomarker assessment, medication monitoring, adverse-event reporting, and long-term follow-up are required to confirm these findings.

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